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DIVISION OF PUBLICATIONS.

FARMERS' BULLETINS

Nos. 1076-1100,

354 2d.

WITH CONTENTS AND INDEX.

PREPARED UNDER THE SUPERVISION OF

JOHN L. COBBS, Jr.

CHIEF, DIVISION OF PUBLICATIONS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1921.

BINDING
JAN 17 '44

405719

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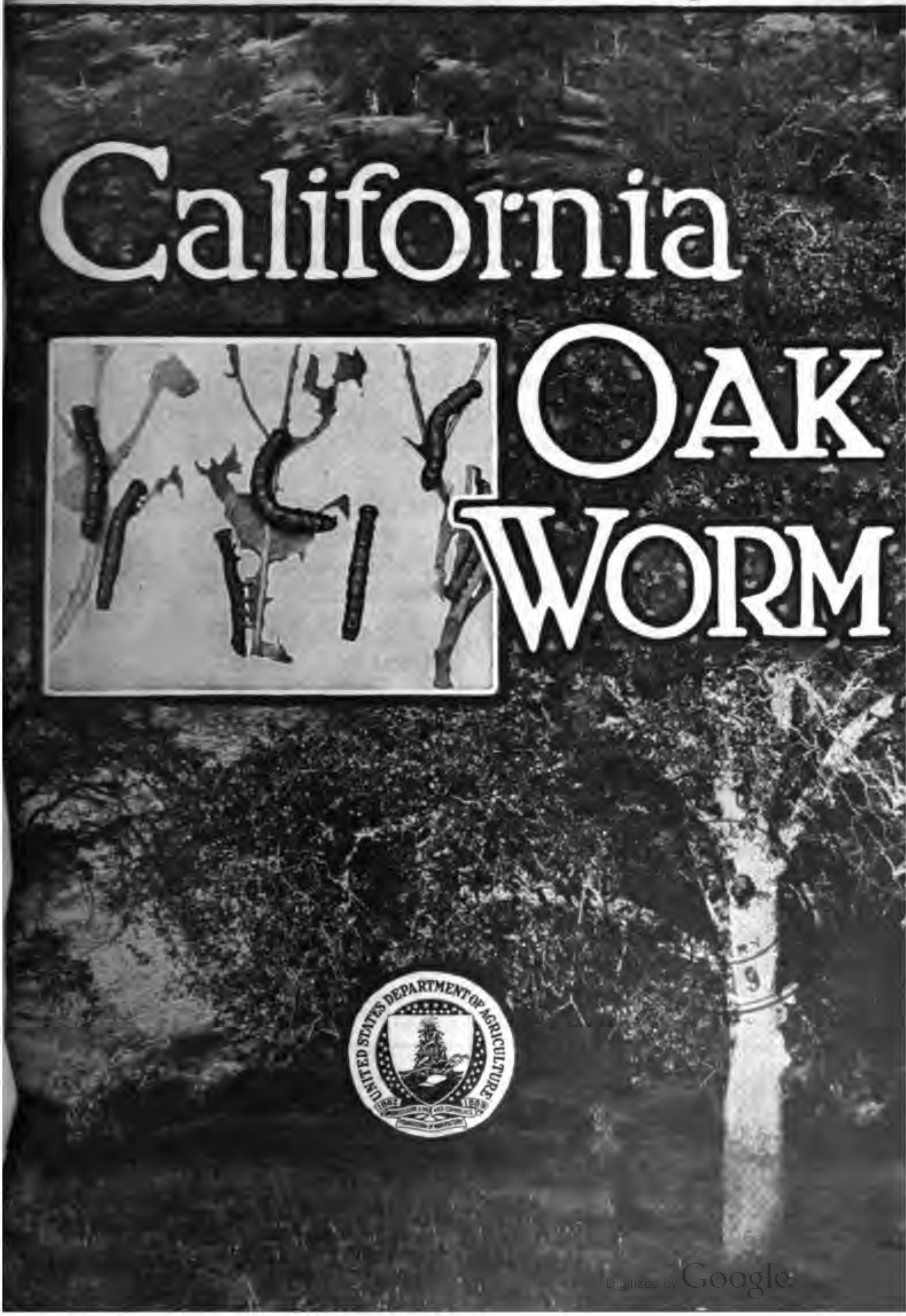
Farmers' Bulletin 1076

United States Department of Agriculture

California Oak Worm



THE LIVE OAK and the valley oak, which are characteristic of the landscape of central California, often are stripped of their leaves by a dark-striped worm which is the young stage of a light-brown moth. Besides stripping the trees of their leaves and making the owner think that they are dead, the worm crawls on lawns, walks, fences, and into houses, swimming pools, etc., becoming a general nuisance.

Two generations of the pest occur during the year. The worms are most noticeable during April and May and again in August and September; the moths, during June and July and again in October and November.

The best method of control is to spray the worm-infested trees with a mixture of 3 to 5 pounds of arsenate of lead paste, or 1½ to 2½ pounds of the dry powder, dissolved in 50 gallons of water.

This should be done while the worms are small. The live oaks should be sprayed in April and again, if necessary, about the 1st of August, when the deciduous oaks are sprayed.

This bulletin describes and illustrates the worm and its work, tells about its habits and natural enemies, and explains the methods of control.

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief
Washington, D. C. February, 1920

CALIFORNIA OAK WORM.[1]

By H. E. BURKE, *Specialist*, and F. B. HERBERT, *Scientific Assistant, Forest Insect Investigations.*

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ECONOMIC IMPORTANCE.

THE most important and characteristic native shade trees of the coast valleys of central California are the live oak[2] and the white or valley oak.[3] As a general rule these splendid trees are healthy and vigorous, but at times they are preyed upon by a number of destructive insects, some of which cause defoliation and give the trees a very unhealthy appearance.

Probably the worst of these from the standpoint of the general public is the California oak worm or moth. This pest not only strips the trees of their leaves, making them worthless for shade or ornament and giving them the appearance of being dead, but it also makes a general nuisance of itself by crawling on sidewalks, lawns, and fences, and into houses, swimming pools, and other places.

It should not be confused with the western oak looper,[4] a true measuring worm, which defoliates oaks similarly in Oregon and Washington.

HISTORY.

So far as can be determined the oak worm is a native of California. Ever since the days of the first settlement by the white man it has attracted his attention at regular intervals because it occurs in enormous numbers every few years and completely defoliates the oaks. Whenever the pest has escaped its natural enemies it has become exceedingly abundant and injurious, but when the natural enemies have overtaken it they have so reduced its numbers that for the time being it attracts no attention.

---

[1] *Phryganidia californica* Pack., family Dioptidae, order Lepidoptera.

[2] *Quercus agrifolia* Nee.

[3] *Quercus lobata* Nee.

[4] *Therina somniaria* Hulst.

The oaks were badly defoliated by the worms in 1851, 1875, 1895, 1908, 1913, and 1917.

DISTRIBUTION AND FOOD PLANTS.

The oak worm is most abundant in the San Francisco Bay region, but occurs throughout most of the coast region where the live oak grows, from Sonoma County to Southern California. Besides the live oak and the white oak, the insect also feeds on various other species of native and introduced oaks, the American chestnut,[1] and in some cases on the blue gum.[2]

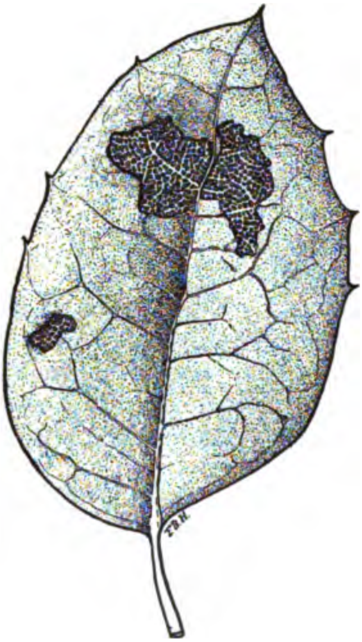

FIG. 1.—Live-oak leaf with upper surface partly eaten by California oak worms in the first stage. Enlarged.

CHARACTER OF WORK.

The young worms eat the pulp from the surface of the leaf between the netted veins, feeding on either surface but more often on the upper (fig. 1). This causes light brownish, pitted patches on the leaves, which give them a very characteristic appearance. These darken with age, but the work can be distinguished as long as the leaves remain. The older worms feed on the edges of the leaves, eating everything down to the main ribs. (See title page.) During epidemic infestations practically every green part of the foliage is gone and the deciduous trees are as leafless as in winter. The skeletonized leaves of the white oak soon fall, but those of the live oak remain on the tree for some time.

The worst of the havoc is over about the first of September and then the worms begin to crawl. Some are seeking fresh food and others places for transforming to chrysalids. This moving habit makes them much more of a nuisance to man than the defoliation of his trees. They get into houses and hammocks, and on lawns, sidewalks, and fences. One can not enjoy the shade because of myriads of crawling, squirming worms, and when one has become thoroughly hot and disgusted and decides to take a plunge in the tank or "old swimmin' hole" it will probably be found that the worms are there also and that even a swim is very unsatisfactory during the worm season.

---

[1] *Castanea dentata.*

[2] *Eucalyptus globulus.*

THE INSECT DESCRIBED.

Like all moths, the oak worm has four distinct forms, of which the worm is the feeding and growing form. As soon as the worms are full grown they change into chrysalids, the resting form, from which emerge the moths that are the parents of the race. These mate and the females lay eggs which hatch into the next generation of worms.

THE EGG.

When first laid, the egg (fig. 2) is almost white, nearly spherical, and about one twenty-fifth of an inch in diameter. As the young worm develops inside, the color changes to lemon yellow, brownish red, chocolate brown, and finally to a mottled pinkish gray. The egg also becomes flattened with age and has a slight depression in the outer or topmost end.

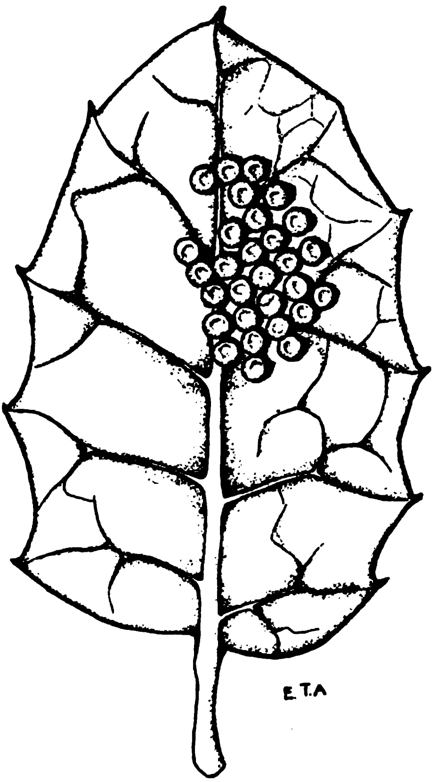

FIG. 2.—Group of eggs of the California oak worm on live-oak leaf. Enlarged.

THE WORM.

When first hatched, the worm (fig. 3) is light colored, sparsely covered with long hairs, and its head is enormous in proportion to the body. It soon acquires some dark spots and dark reddish stripes and after going through five stages and becoming full grown it usually is almost black and nearly hairless. Numerous individuals, however, do not acquire the dark color but retain the lighter tints of the younger stages. The body becomes wider and longer until it is in proportion to the head. When newly hatched the worm is about one-tenth of an inch long and when full-grown about 1 inch.

THE CHRYSALIS.

The chrysalis, a form (fig. 4) which looks something like a mummy, is about one-half an inch long by one-sixth of an inch broad. It varies from whitish to yellow in color and has a number of black lines and splotches upon it.

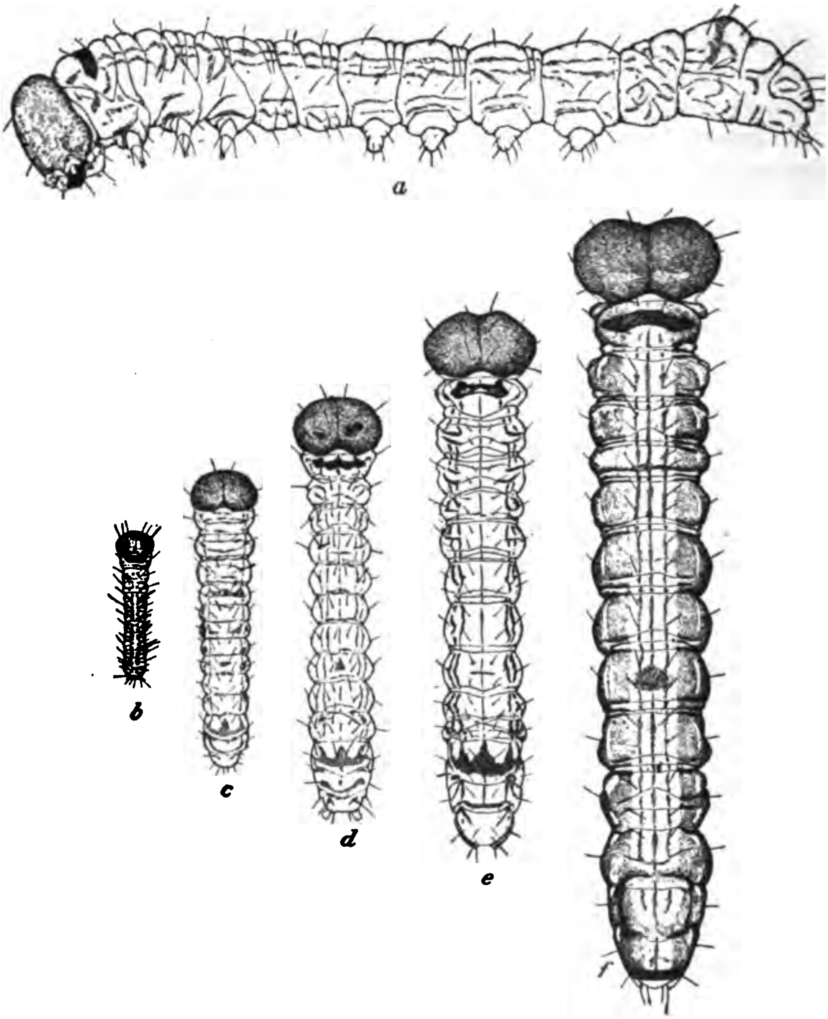

FIG. 3.—The California oak worm: *a*, Side view of full-grown worm of fourth stage about to change to fifth; *b*, newly hatched worm of first stage; *c*, *d*, *e*, *f*, newly changed worms of second, third, fourth, and fifth stages. Enlarged. When newly hatched or changed the head is wider than the body, but when each stage has become full grown the body is as wide as the head and has grown proportionately in length.

THE MOTH.

The moth (fig. 5) is light brown with rather prominent dark veins. The body is about one-half an inch long and the wings spread about

1¼ inches. The males have faint yellowish patches near the center of each forewing, and their antennæ, or feelers, are broader and more feathery.

LIFE HISTORY AND HABITS.

The eggs which start the new generations of worms are laid by the female moth in various places—on the leaves of the oaks and many other trees, on the bark of the trunks, on the grass under the trees, and seemingly on anything that she happens to fly against or crawl upon. Only those eggs laid on the oak, chestnut, and eucalyptus leaves, however, produce worms that have a chance to mature. The worms from the eggs laid in other places are without suitable food and must starve. And even the oaks are very often disappointing. The leaves of the deciduous species usually fall off in the autumn and the worms hatched from the eggs laid on them by the fall generation of moths starve on the ground. Sometimes, however, as in the fall of 1917, the old leaves do not fall until the new ones come out and then the worms on them winter over in good condition.

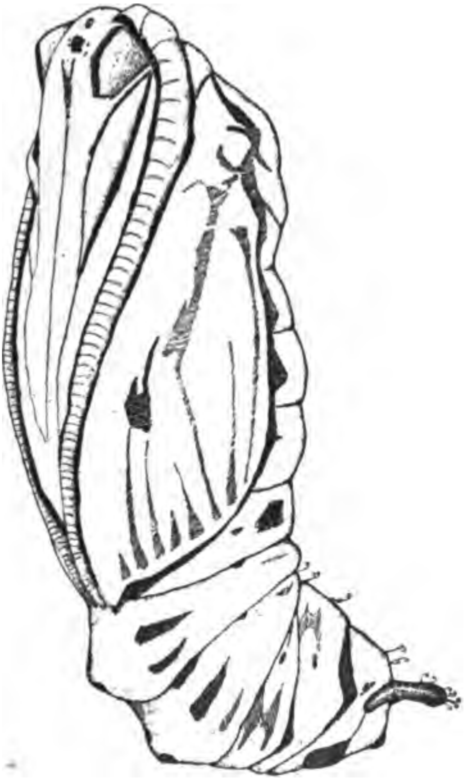

FIG. 4.—The chrysalis or resting stage of the California oak worm. Enlarged.

The great majority of the eggs laid on the leaves are laid in more or less regular rows in groups of from 2 to 40 on the under surface of the leaf (fig. 2). They hatch in from 10 to 15 days in the summer time and from that to 4 months in the winter time.

Soon after it hatches, the young worm takes its first meal by eating the eggshell. It then begins to feed on the leaf, usually on the upper surface, eating out the pulp between the veins (fig. 1). During the early stages a number remain together, and their feeding causes large patches of pitted surface to appear. In the later stages the worms scatter and, feeding on the edges of the leaves, eat them down to the larger veins and midribs (see title page).

While it is growing the worm changes its skin from three to six times, going through from four to seven stages (fig. 3). The normal number is five, and nine-tenths of the worms go through that number of stages before they change to the chrysalis. During each successive stage the worm feeds a while, gets larger, rests, and then goes through the transformation to the next larger stage.

Upon becoming full grown it crawls off to some protected place, such as the trunk of a tree, a fence, or a bush, and transforms to the chrysalis.

In about two weeks a moth emerges from each healthy chrysalis and, if a male, seeks a female and mates. The female then lays its eggs on an oak leaf or almost anything that happens to be near. Eggs have hatched on rye grass, marsh mallow, china lettuce, elm, and cypress bark, but the young worms died soon after hatching.

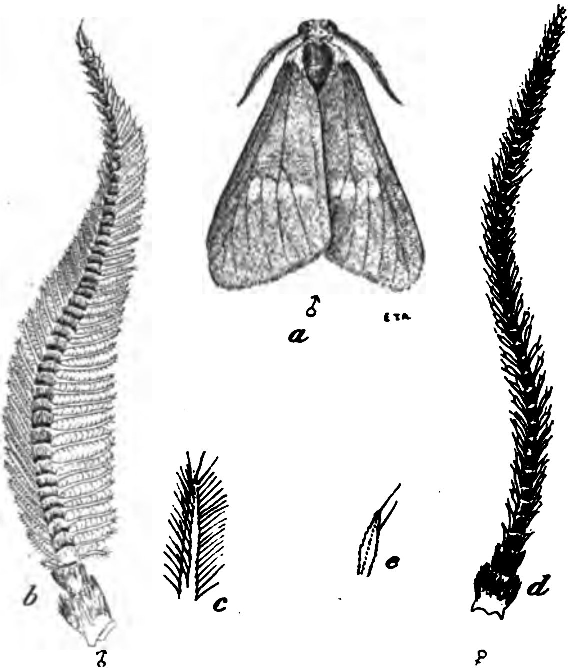

FIG. 5.—The moth or parent stage of the California oak worm: *a*, Male, enlarged (the female has no light spots on the wings and the antennæ are slender); *b*, antenna of male, more enlarged; *c*, bristle from same, much enlarged; *d*, antenna of female, enlarged; *e*, bristle from same, much enlarged.

SEASONAL HISTORY.

Two generations of the oak worm occur each year. From eggs laid in October and November worms hatch in November, December, January, February, and even March. These become full grown in May and June and transform to chrysalids, from which the moths issue about two weeks later. The greatest emergence is about the last of June. Mating soon takes place and the eggs of the second or summer generation are laid. These hatch in about two weeks, the majority hatching about the middle of July, and the worms become full grown in September and October, when they form their chrysalids and issue as moths about two weeks later. Mating soon takes place and the eggs of the winter generation are laid. Most of the moths from the summer generation of worms fly in November, and most of those from the winter generation fly in June.

CONDITIONS FAVORABLE TO OUTBREAKS.

As the deciduous oaks usually shed their leaves before the new ones come out in the spring, most of the worms of the winter generation living on them starve, and only those on the live oak live over to perpetuate the species. Without the live oak, therefore, the insect would become extinct, and for this reason localities with deciduous oaks and without live oaks have nothing to fear from it.

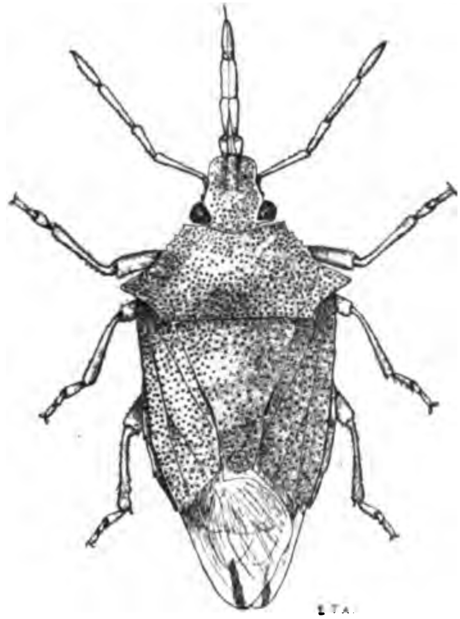

FIG. 6.—The spined soldier bug, an enemy of the oak worm during the egg, worm, and chrysalid stages. Much enlarged.

So far as can be determined at present, the main condition favorable to an outbreak in the live-oak territory is the lack of natural enemies, brought about by starvation caused by the scarcity of the oak worm, which they have almost exterminated. When the natural enemies have reduced the worm to its lowest ebb, many of the natural enemies die from lack of food, and the worms increase again and become epidemic. This condition exists until the few parasites that are left have time to multiply and their descendants increase to the maximum; then down goes the worm to stay until the enemies starve and become scarce again.

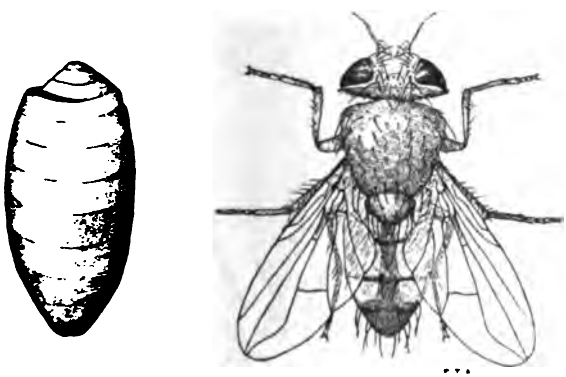

FIG. 7.—A fly parasitic on the full-grown California oak worm.

NATURAL ENEMIES.

INSECT PREDATORS AND PARASITES.

Thus, one of the principal reasons why the oak worm has a succession of periods of great abundance followed by periods of great scarcity is that its insect foes concentrate in deadly attack as soon as the worm does become abundant. The eggs, all stages of the worms, and the chrysalids are punctured and sucked dry by the spined soldier bug[1] (fig. 6); the larger worms are destroyed by a small grayish fly[2] (fig. 7) which lives within their bodies during its maggot stage; and the chrysalids are killed by the grubs of two wasplike parasites, the black and yellow chalcid[3] (fig. 8) and the oak worm ichneumonid[4] (fig. 9), which feed on the internal organs.

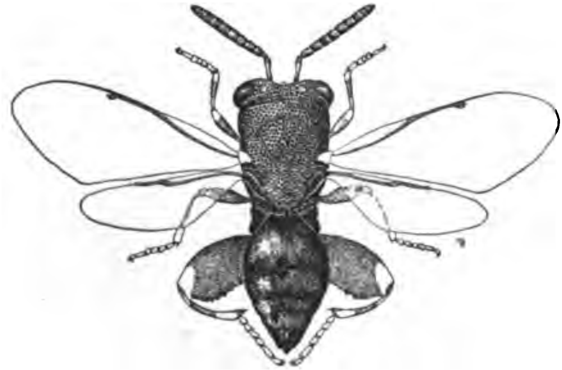

FIG. 8.—The black and yellow chalcid, a parasite on the chrysalis of the California oak worm.

BACTERIAL DISEASE.

Another important natural enemy of the oak worm is an undetermined disease supposed to be bacterial in origin. Often when the worms occur in the greatest numbers the disease appears among them and kills thousands. Worms killed by it become dark and flaccid and hang limply from twigs, branches, fences, houses, and wires.

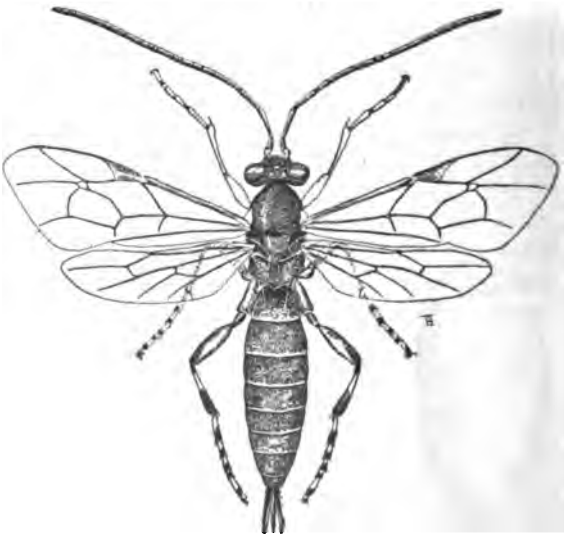

FIG. 9.—The oak worm ichneumonid, a parasite on the chrysalis of the California oak worm.

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[1] *Podisus maculiventris* Say.

[2] *Thryptocera flavipes* Coq.

[3] *Chalcis abiesiae* Girault.

[4] *Itoplectis behrensi* (Cress.).

METHODS OF CONTROL.

During that period of this never-ending warfare at which the worm is at its greatest increase, the trees suffer, and man must join the fight if he would save the appearance of his trees for the year and prevent the nuisance of a plague of the worms.

The best spray to use against the worm is 3 to 5 pounds of arsenate of lead paste, or 1½ to 2½ pounds of arsenate of lead in dry powdered form, dissolved in 50 gallons of water. A power sprayer should be used, the mixture should be kept well agitated, and the entire foliage should be covered with a fine mist.

To get the best results the trees should be sprayed while the worms are in the younger stages. They are more easily killed then and have done very little damage. Do not wait until the trees are stripped and the worms are full grown.

If the moths are abundant about the trees in June and early July a heavy crop of worms probably will appear during the late summer, with the resulting leafless trees. To prevent this, spray both live and deciduous oaks during the last of July or the first of August. If the moths are common in October and November the worms will do the most damage to the live oaks in April and May. To prevent this, spray during March and April. The important thing is to wait until most of the eggs of the generation have hatched and then to spray at once while the worms are small.

If only one spraying is to be given, spraying the live oaks in the spring is the better time, for, under the usual California rainless summer conditions, the poison will remain on the leaves until September and will catch both generations of worms.

As a usual thing the property owner will get better results for less money by hiring a commercial tree sprayer to do the work. Choose a tree sprayer by the reputation he has made, and then follow his advice.

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Roger C. Smith.
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GAME LAWS FOR 1919

A SUMMARY OF THE PROVISIONS OF FEDERAL, STATE, AND PROVINCIAL STATUTES

GEO. A. LAWYER
Chief, U. S. Game Warden, and

FRANK L. EARNSHAW
Assistant, Interstate Commerce in Game

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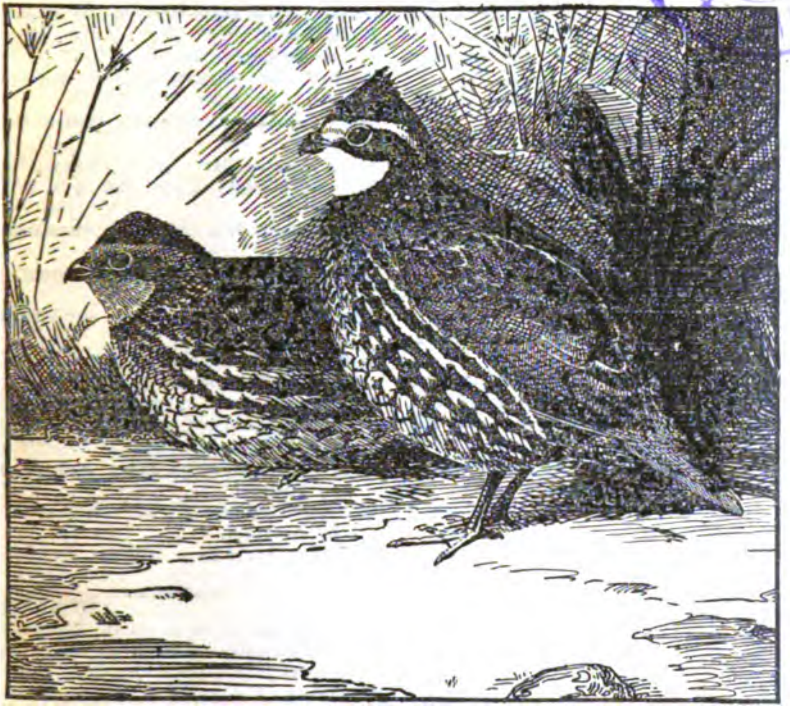

Bob-white

FARMERS' BULLETIN 1077

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief

Washington, D. C. August, 1919

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Delaware: Chief game warden, Dover.

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Kentucky: Executive agent, game and fish commission, Frankfort.

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Nebraska: Chief deputy, game and fish commission, Lincoln.

Nevada: State fish and game warden, Carson City.

New Hampshire: Fish and game commissioner, Sunapee.

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New Mexico: Game and fish warden, Santa Fe.

New York: Secretary of conservation commission, Albany.

North Carolina: Secretary Audubon Society of North Carolina, Raleigh.

North Dakota: Secretary, game and fish board, Steele.

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Oklahoma: State game warden, Oklahoma City.

Oregon: State game warden, Portland.

Pennsylvania: Secretary, board of game commissioners, Harrisburg.

Rhode Island: Chairman, commissioners of birds, Rumford.

South Carolina: Chief game warden, Columbia.

South Dakota: State game warden, Pierre.

Tennessee: State game and fish warden, Nashville.

Texas: Game, fish, and oyster commissioner, Austin.

Utah: Fish and game commissioner, Salt Lake City.

Vermont: Fish and game commissioner, Cambridge.

Virginia: Commissioner of game and inland fisheries, Richmond.

Washington: Chief game warden and State fish commissioner, Seattle; chief deputy game warden, Spokane.

West Virginia: Forest, game, and fish warden, Philippi.

Wisconsin: Secretary, conservation commission, Madison.

Wyoming: State game warden, Lander.

CANADA.

Alberta: Chief game guardian, Edmonton.

British Columbia: Game conservation board, Victoria.

Manitoba: Chief game guardian, Winnipeg.

New Brunswick: Chief game and fire warden, Richibucto.

Northwest Territories: Commissioner of parks, Ottawa.

Nova Scotia: Chief game commissioner, Halifax.

Ontario: Superintendent game and fisheries, Toronto.

Prince Edward Island: Game inspector, Charlottetown.

Quebec: General inspector of fisheries and game, Quebec.

Saskatchewan: Chief game guardian, Regina.

Yukon: Gold commissioner, Dawson.

Colony of Newfoundland: Secretary, department of marine and fisheries, St. Johns.

GAME LAWS FOR 1919.

A SUMMARY OF FEDERAL, STATE, AND PROVINCIAL STATUTES.

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REVIEW OF LEGISLATION OF 1919.

The objects of this bulletin, containing the twentieth annual summary of Federal and other game laws and regulations, are to present the provisions of game legislation in convenient form for sportsmen and others, and to show its general condition and trend from year to year.[1]

Legislative sessions were held in 44 States, in 41 of which more or less extensive changes were made in the game laws. While the number of game laws enacted does not equal the total number passed in other years when most of the legislatures were in session, the volume compares favorably with records of previous years, owing to the number of States which amended and codified their game legislation. Arkansas, Illinois, Minnesota, Ohio, Texas, and Utah passed general measures revising their game laws. Considerable progress was made along the line of harmonizing State legislation with the migratory-bird treaty act and the regulations thereunder. In South Carolina the Federal regulations were adopted as the law of the State. In New York the seasons for Long Island, and in Arkansas, Illinois, Minnesota, Ohio, South Dakota, and Texas open seasons or other provisions, were made to conform to the Federal regulations.

BIG GAME.

Some very beneficial legislation for the protection of big game was enacted this year, among the most noteworthy of which was the action of Maine in repealing the provision which allowed residents to export deer. Federal investigations disclosed that residents of Maine and New Hampshire had been illegally shipping large numbers of deer to the Boston markets, and the magnitude of this illegal traffic, as indicated by the convictions secured in Federal courts, was doubtlessly instrumental in initiating this legislation. Another most important provision of the legislation in Maine, and one of far-reaching consequences, was that prohibiting the use of deer and moose in lumber camps. The deer seasons were shortened from 5 to 15 days in Maine, New Mexico, Vermont, and Wyoming. Close seasons throughout the year were prescribed for does in Missouri and Wyoming, and for all deer in Ohio and West Virginia. The limits on deer were reduced from two to one a season in New York and Ontario. Nova Scotia lengthened the season on deer one week, and New York, Texas, and Vermont repealed laws protecting does.

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[1] Provisions relating to methods of capture, game refuges, enforcement of laws, disposition of fines and fees, and matters of minor importance are omitted. These may be found by reference to the laws themselves or to pamphlet editions of the game laws, obtainable in most of the States from proper officials. Provisions relating to seasons, licenses, limits, possession, sale, and export, and a few miscellaneous matters have been compiled and grouped under State and other Governments, alphabetically arranged, thereby enabling persons interested to secure conveniently a brief synopsis of the laws.

Saskatchewan closed the Province to elk hunting, and West Virginia continued the close term on these animals until 1927; Wyoming shortened the open season two weeks, reduced the limit from two to one a season, and repealed the provision permitting a resident to kill one additional elk under a special $10 license. Idaho lengthened the season two weeks on elk in counties having an open season, and Montana modified the seasons in certain counties and opened a few counties to elk hunting which heretofore had been closed.

Mention should here be made of the program evolved by the Forest Service and the Bureau of Biological Survey for the conservation and maintenance of elk in the Yellowstone National Park region. Here is found the greatest aggregate of large game now in existence in such a limited area within the United States. The program is the result of investigations by these two bureaus of the Department of Agriculture, made with a view to devising a practicable plan to conserve the remnant of this once numerous and widely distributed noble game animal.[1]

Maine permitted moose to be hunted during the last ten days of November, the first open season on these animals since 1915; and Nova Scotia shortened the open season two weeks. Wyoming shortened the season on sheep six weeks and extended the term of protection on moose and antelope until 1925. Alberta lengthened the open season two weeks on mountain sheep and goats.

SEASONS ON GAME BIRDS.

The grouse season was closed in New Mexico, Texas, Vermont, and Wyoming; in Maine and Ohio existing open seasons were shortened; and in West Virginia the number of grouse allowed to be taken in a season was reduced from 25 to 20. In Michigan and Pennsylvania, where the seasons on ruffed grouse were closed in 1918, hunting is again permitted this year. Alberta lengthened the season on grouse and ptarmigan two weeks.

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[1] Graves, Henry S., and Nelson, E. W., Our national elk herds: a program for conserving the elk on national forests about the Yellowstone National Park. U. S. Dept. Agt. Dept. Circ. 51, pp. 34, figs. 19, June, 1919.

Arkansas and South Carolina each shortened the open season on quail one month, and West Virginia reduced the limit from 96 to 60 a season. In Idaho the season on sage hens was opened throughout the State during the last two weeks in August; Wyoming shortened the season two weeks and reduced the daily bag limit from 6 to 4; and Oregon lengthened by two weeks the season east of the Cascades. Wild turkeys were protected until 1921 in West Virginia and the seasons were shortened one month in Missouri and from 15 days to 6 weeks in New Mexico. South Carolina lengthened the season two weeks and established a limit of 20 turkeys a season. Missouri provided that 100 petitioning householders may obtain a referendum vote at a general election upon the question of a 2-year close season on quail in any county.

ADMINISTRATION.

One of the most important features of the game legislation of 1919 was the effort to maintain efficient organizations for the enforcement of the laws. A very general effort was made to keep pace with the increased cost of living, which necessitated the payment of a living wage for warden work and competition with salaries and wages paid by private concerns. No less than 11 States—Connecticut, Idaho, Missouri, New Hampshire, New Mexico, New York, Oklahoma, Oregon, Texas, Vermont, and Wyoming—authorized increases in compensation for State wardens or deputies. In Indiana and Ohio State game officials were authorized to fix the compensation of all their employees, and in New Jersey the salaries of certain employees of the board of fish and game commissioners are required to be fixed in accordance with schedules furnished by the civil-service commission.

Idaho, in keeping with the movement in many States, created nine departments in which to centralize and systematize the civil administration of State affairs, and placed the fish and game bureau in the department of law enforcement. In West Virginia a $1 State-wide resident license law was enacted to replace the 1915 act requiring $3 licenses of residents hunting outside their counties of residence. The $1 resident license, with an exemption to landowners, tenants, and members of their families hunting on their own lands, has proved popular throughout the country, is not burdensome on the individual hunter, and invariably insures financial support for adequate warden service, restocking, and other lines of legitimate game conservation. West Virginia made deep inroads into the game and fish protection fund maintained by receipts from the sale of hunting licenses, by providing that 20 per cent thereof should be expended in restocking streams with fishes, and 10 per cent set aside for bounties on certain animals and birds. These diversions, together with the cost of issuing licenses and collecting the fees therefor, will serve to reduce the amount available for game protection to about 50 per cent of the receipts from the sale of hunting licenses.

South Carolina made the resident hunting-license law applicable throughout the State. Texas increased the fee for resident hunting licenses from $1.75 to $2 and repealed the provision permitting hunting without a license in counties adjoining the county of residence. Maine prescribed a 25-cent registration certificate for residents, good so long as the holder remains a citizen of the State. Utah abolished the distinction between resident and nonresident hunters and prescribed a $2 license fee for citizens of the United States hunting in that State. Legislation along this line has been advocated for many years by prominent sportsmen, but Utah is the first State to adopt it.

In Indiana the fish and game interests were placed under the jurisdiction of the newly created department of conservation. The four conservation commissioners and the chiefs of divisions are empowered to administer oaths, subpœna witnesses, and to require public officials, corporations, associations, and individuals to produce books, records, and information for lawful purposes under the act. The fish and game protection and propagation fund was continued, but funds therein in excess of $50,000 are to revert to the State treasury at the end of any fiscal year.

GAME REFUGES AND PRESERVES.

Marked progress was made in the establishment of game sanctuaries, and no less than a dozen States enacted legislation with reference to this very important factor in game conservation. All State lands in Alabama, State, county, and municipal parks in Delaware, and all school sections and educational lands in Nebraska were declared game refuges and all hunting thereon prohibited. Minnesota prohibited hunting in or within three miles of the corporate limits of Duluth, Minneapolis, and St. Paul. Special refuges created include the Catalina Mountain preserve in Arizona; the Colorado State Game Refuge, in the vicinity of the Rocky Mountain National Park; the game and fish preserve in Loudon County, Tenn.; the Dixie, Fish Lake, Heaston, Cache, and Strawberry Preserves in Utah, and the Splitrock special game-animal preserve in Wyoming. Vermont authorized the commissioner to establish such game refuges and sanctuaries as are recommended by the United States Biological Survey, and a tentative selection of a preserve has already been made by the bureau. The boundaries of the Gallatin preserve in Montana and those of the Big Horn refuge in Wyoming were modified to some extent. In Oregon and Illinois the State authorities were authorized to establish refuges by contract on private lands, and in South Dakota to acquire public or private property for the protection and propagation of game birds.

MISCELLANEOUS PROVISIONS.

California, Illinois, Maine, and Minnesota prohibited hunting from automobiles or motor vehicles, and California and Michigan made it illegal also to hunt or shoot game birds from airplanes. Colorado prohibited aliens from hunting or owning a shotgun, rifle, or pistol. Illinois prohibited the shipment of game by parcel post. Indiana authorized the department of conservation to encourage and assist in the organization and establishment of fish and game protective associations in the State. In New York provision was made for registering and licensing guides in the forest-preserve counties, and such guides are required to comply with rules and regulations prescribed by the commissioner. Vermont provided for establishing around commercial orchards having an area of 10 acres or more open zones in which deer may be killed at any time.

SUMMARY OF LAWS RELATING TO SEASONS, LICENSES, LIMITS, SALE, AND EXPORT.

The dates of open seasons for migratory game birds shown under the various States and Provinces are the times when these birds may be hunted without violating either State laws or Federal regulations.[1] Federal regulations now prohibit shooting from sunset to half an hour before sunrise.

The regulations under the Federal migratory-bird treaty act prohibit throughout the United States the killing at any time of the following birds:

Band-tailed pigeon; little brown, sandhill, and whooping cranes; wood duck, swans; curlews, willet, upland plover, and all shorebirds (except the black-bellied and golden plovers, Wilson snipe or jacksnipe, woodcock, and the greater and lesser yellowlegs); bobolinks,[2] catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, hummingbirds, kinglets, martins, meadowlarks, nighthawks or bull-bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whip-poor-wills, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects; and also auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

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[1] The full text of the migratory-bird treaty, act, and regulations will be found on pages 65–77.

[2] See order of the Secretary permitting bobolinks or reedbirds to be killed in a few States for the protection of rice crops in the south, p. 77.

In some States certain days of the week constitute close seasons throughout the time in which killing is permitted. Hunting on Sunday is prohibited in all States and Provinces east of the one hundred and fifth meridian except Illinois, Louisiana, Michigan, Texas, Wisconsin, and Quebec. Mondays constitute a close season for waterfowl locally in Maryland and North Carolina; and certain other week days for waterfowl in several favorite ducking grounds in Maryland, Virginia, and North Carolina. Hunting is prohibited on election day in Maryland in Allegany, Baltimore, Cecil, Charles, Frederick, and Harford Counties; and when snow is on the ground in New Jersey, Delaware, Virginia, and Maryland.

The county laws of North Carolina, which are too numerous to be included satisfactorily, are not incorporated in the following summary, which otherwise may be regarded as a practically complete résumé of the regulations now in force.

The migratory-bird treaty-act regulations permit the possession of migratory game birds during the open season and the first 10 days following the close of the season. This provision has been considered in connection with State laws, and when migratory game birds may be legally possessed under Federal regulations and State laws during any part of the close season, it has been stated under the heading "Bag limits and possession." Possession of nonmigratory game during the close season is generally prohibited by State laws, but when an extension of a few days or a special season is provided for either possession or sale, attention is called thereto.

Under the Federal migratory-bird treaty act the sale of all migratory game birds is prohibited throughout the United States except birds taken for scientific or propagating purposes, or waterfowl raised on farms or preserves under proper permit from the Secretary of Agriculture.

In stating the open seasons[1] the plan of the New York law, to include *the first and the last days thereof*, has been followed. The difficulty of securing absolute accuracy in a statement of the seasons is very great, but the following summaries have been submitted to the proper State or Provincial game commissioners for approval, and are believed to be free from material errors. Seasons which apply only to special counties are placed to the left of the column containing those for the State in general. Species (except migratory birds protected throughout each year by Federal regulation) on which the season is closed for a term of years or an indefinite period are grouped under the term "No open season." Provisions of State laws prohibiting hunting at night, between sunset and sunrise, or during certain hours, are not included.

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[1] For open seasons on fur-bearing animals, see Farmers' Bulletin —, 1919.

Persons are advised to secure from State game commissioners[1] the full text of game laws in States where hunting is contemplated.

ALABAMA.

Open seasons:[2]

	Dates inclusive.
Deer (male)	Nov. 1–Jan. 1.
Squirrel (black, gray, fox)	Nov. 1–Feb. 1.[3]
Bear, quail (partridge)	Nov. 1–Mar. 1.
Ruffed grouse (pheasant), introduced pheasant, or other introduced game bird	Nov. 15–Dec. 15.
Wild turkey gobbler	Dec. 1–Apr. 1.
Turtle dove	Oct. 16–Jan. 31.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, coot (mudhen)	Nov. 1–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does, elk (1925); hen turkeys.

Hunting licenses: Nonresident or alien, $15. Resident: State, $3; county, $1. Trapping (bears and other fur-bearing animals), $10. Issued by probate judges. Landlords, tenants, and members of families may hunt or trap on own land during open season without license. Written permission required for hunting or trapping on land of another.

Bag limits and possession: One deer, 10 squirrels, 2 turkey gobblers, 25 of each other kind of upland game bird a day; 25 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 25 sora, and 25 in all of other rails, coots, or gallinules, 25 doves a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except that a nonresident licensee may take with him, openly, game he has lawfully killed, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week.

State game and fish commissioner may issue $1 permit to any person to capture or transport not more than 10 pairs of any one species of game bird for scientific or propagating purposes.

ALASKA.

Open seasons:[4]

	Dates inclusive.
North of latitude 62°—	
Moose (females and yearlings protected all the year), caribou, sheep	Aug. 1–Dec. 10.
South of latitude 62°—	
Deer with horns 3 inches long (Southeastern Alaska) (see exception)	Aug. 15–Oct. 31.
Exception: Deer on Duke, Gravina, Kodiak, Long, Kruzof, San Juan, Suemez, Zarembo, Hawkins, Hinchinbrook, and Montague Islands, 1921.	
Mountain goat in Southeastern Alaska east of longitude 141° and on Kenai Peninsula	Sept. 1–Oct. 31.
Moose (females and yearlings protected all the year), caribou, sheep (see exception)	Aug. 20–Dec. 31.
Exception: Caribou on Kenai Peninsula; sheep, Kenai Peninsula, east of longitude 150°	July 15, 1921.
Brown bear	Oct. 1–July 1.
Throughout Territory—	
Grouse, ptarmigan	Sept. 1–Mar. 1.
Duck, goose, brant, Wilson snipe, black-bellied and golden plovers, yellowlegs, coot, gallinule	Sept. 1–Dec. 15.

No open season: Females and young of deer and mountain sheep, mountain goat kids, and fawns of caribou, south of Arctic Circle.

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[1] See p. 2. A full list of names and addresses of officials and organizations concerned with the protection of birds and game will be found in Dept. Circ. 63, U. S. Dept. Agr., 1919.

[2] *Alabama:* Hunting prohibited on all State lands.

[3] Squirrels may be killed at any time on own premises when destroying property.

[4] *Alaska:* Game animals or birds may be killed at any time for food or clothing by native Indians or Eskimos, or by miners or explorers in need of food, but game so killed may not be shipped or sold.

Hunting licenses: Nonresident, $50; nonresident alien, $100. Guide, first-class, $25 (American citizen); second class, $7.50 (native of Alaska—fee fixed by governor).

Shipping licenses: Resident, $40 (export of heads or trophies); $10 (single trophy of caribou or sheep); $5 (single trophy of deer, goat, or brown bear). Special license for shipping one moose killed south of latitude 62°, $150.

(Not more than one general ($40) license and two special ($150) moose licenses issued to one person in one year. Each shipper must file with the customs office at port of shipment an affidavit that he has not violated the game law; that the trophy to be shipped has not been bought or purchased, has not been sold, and is not shipped for purpose of sale; that he is the owner of the trophy, and, in case of moose, whether the animal from which it was taken was killed north or south of latitude 62°.)

Bag limits and possession: Three deer, 2 moose, 3 caribou, 3 sheep, and 3 brown bears a season; 25 grouse or ptarmigan, 25 ducks, 8 geese, 8 brant a day, 25 in all in possession; 15 in all of plovers and yellowlegs, 25 Wilson snipe, 25 shorebirds in possession; 25 in all of coots and gallinules a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale prohibited of heads, hides, and skins of all protected game; deer in Southeastern Alaska; moose, caribou, sheep, and goats south of Chugatch or Coast Range Mountains, including Kenai Peninsula and east to longitude 141°. Serving deer or caribou on vessels east of Unimak Pass also prohibited.

Sale of migratory birds prohibited.

Permitted: Carcasses of all game (except migratory birds, and deer, moose, and sheep as above stated) may be sold during the open season and 15 days thereafter.

Export: Export prohibited of deer, moose, caribou, sheep, goat, bear, or hides of these animals; wild birds, except eagles, or any parts thereof: *Provided*, specimens may be exported under restrictions imposed by the Secretary of Agriculture and trophies of big game under licenses issued by the governor. (See licenses.)

ARIZONA.

Open seasons:	*Dates inclusive.*
Deer (male), wild turkey	Oct. 1–Nov. 1.
Quail (except bobwhite)	Oct. 15–Dec. 31.
Mourning doves	Sept. 1–Dec. 15.
White-wings	July 15–Dec. 31.
Duck, goose, brant, Wilson snipe, coot, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Oct. 15–Dec. 15.
Rail, other than coot and gallinule	Oct. 15–Nov. 30.

No open season: Does, spotted fawns, elk, antelope, sheep, goat, bobwhite, grouse, pheasant.

Hunting and fishing licenses: Nonresident or alien: Game and fish, $20; birds (except turkeys) and fish, $10. Not issued to applicant under 12 years of age. Resident: Game and fish, $1.25. Issued by game warden, designated deputies, and clerk, board supervisors.

Hunting on own land permitted without license during open season. American-born resident under 17 years of age may hunt without a license, if accompanied by a holder of a general license.

Bag limits and possession: One deer, 2 turkeys a season; 20 ducks, 8 geese, 20 coot, 15 plovers and yellowlegs, and 20 rail, but not more than 20 in all of waterfowl, plovers, yellowlegs, rails, and coots a day or in possession; 25 quail, and 25 doves and white wings a day or in possession; 25 Wilson snipe a day. Possession of plovers, yellowlegs, rails, and doves permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except for scientific or propagating purposes under permit from State warden.

ARKANSAS.

Open seasons:	*Dates inclusive.*
Deer (buck), bear	Nov. 10–Jan. 15.
Squirrel	May 15–Jan. 15.
Turkey gobblers	Nov. 10–Jan. 15. Mar. 1–May 1.
Quail (partridge)	Nov. 20–Feb. 1.
Duck, goose, Wilson snipe, coot, gallinule	Nov. 1–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Black-bellied and golden plovers, yellowlegs, dove	Sept. 1–Dec. 15.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does, fawns, wild turkey hen, pheasant, grouse, prairie chicken (1922).

Hunting licenses:[1] Nonresident for deer, bear, and turkey, $15; resident, $1.10. For dog in hunting, $1.50. Issued by State treasurer and circuit clerks. No license required of citizen to hunt or fish during open season on own premises. Hunting prohibited on inclosed lands without consent of owner.

Bag limits and possession: Two deer, 1 bear, 4 turkeys a season; 15 squirrels, 20 quail (40 in possession); 25 doves, 25 ducks (50 in possession); 8 geese, 8 brant, 25 Wilson snipe, 6 woodcock, 15 in all of plovers and yellowlegs, 25 in all of rails, coots, and gallinules a day or in possession. Possession of game permitted during first 10 days of close season.

Sale: Sale prohibited of all protected game (except squirrels).

Export: Export of all game prohibited, provided a nonresident, under his license and affidavit that game was legally taken by himself and is not for sale, may take with him one day's bag limit. Commission may permit game to be shipped from the State for propagation.

CALIFORNIA.[2]

Open seasons:	*Dates inclusive.*
Male deer (except spike bucks), in districts 1, 1½, 4½, 23, 24, 25, and 26	Aug. 15–Oct. 14.
In districts 2 and 3	Aug. 1–Sept. 14.
In district 4	Aug. 15–Sept. 15.
Bear (black, brown)	Oct. 15–Mar. 1.
Tree squirrel	Sept. 1–Dec. 31.
Cottontail and brush rabbits, mountain, valley, and desert quail (see exceptions)	Nov. 15–Jan. 31.
Exceptions: Mountain, valley, and desert quail, districts 4 and 4½	Oct. 16–Dec. 31.
Mountain quail, districts 1, 23, 24, 25, and 26	Sept. 1–Nov. 30.
Grouse	Sept. 15–Oct. 14.
Sage hen (except in district 4 no open season)	Aug. 15–Sept. 30.
Dove	Sept. 1–Oct. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot (mudhen), gallinule	Oct. 16–Jan. 31.

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[1] *Arkansas:* Fishing licenses to use artificial bait: Resident, $1.10; nonresident, general, $5; special 15-day (trip) license, $1.10.

[2] *California:* Of the 57 fish and game districts created under the act of 1917, as amended in 1919, 6 (1, 1½, 2, 3, 4, and 4½) are properly hunting districts; 23, 24, 25, and 26 are fishing districts, but are open to hunting; the other 47 are fishing districts or fish and game refuges.

District 1 comprises the northern part of the State, the Sierras, and the east half of the Sacramento and San Joaquin Valleys, including all counties not included in districts 1½, 2, 3, and 4.

District 1½ comprises the counties of Del Norte, Siskiyou, and Humboldt.

District 2 comprises that part of the State south of Humboldt and Tehama Counties, west of the Sacramento River and north of San Francisco Bay, including the counties of Mendocino, Glenn, Colusa, Yolo, Solano, Napa, Lake, Sonoma, and Marin.

District 3 comprises the region around the southern portion of San Francisco Bay and the coast counties south of the Golden Gate as far as Ventura, including the counties of Contra Costa, Alameda, Santa Clara, San Francisco, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, Ventura; also San Benito and the west half of San Joaquin, Stanislaus, Merced, Fresno, and Kern Counties.

District 4 comprises the counties in southern California, namely, Los Angeles, Orange, Riverside, San Diego, Imperial, and San Bernardino.

District 4½ comprises the counties of Mono and Inyo.

Districts 23, 24, 25, and 26, all located in district No. 1, are as follows:

District 23 comprises the drainage area of Lake Tahoe and the Truckee River in the counties of Placer and Eldorado.

District 24 comprises the drainage area of Silver, Twin, Blue, Meadow, and Wood Lakes in the counties of Alpine and Amador.

District 25 comprises the drainage area of Lake Almanor in the counties of Plumas and Lassen.

District 26 comprises Sixty Lake Basin, part of Rae Lake, and to the south fork of Woods Creek, in Fresno County.

No open season: Doe, spike buck, fawn, elk, antelope, sheep, pheasant, introduced quail or partridge, turkey, rail, plover, yellowlegs.

Hunting licenses:[1] Nonresident, $10; alien, $25 (except those with first papers, fee $10); resident, $1; veterans of Civil War, free of charge. Issued by commissioners and county clerks. Unlawful to hunt in inclosure of another without permission of owner.

Bag limits and possession: Two deer, 12 tree squirrels a season; 15 cottontail or brush rabbits a day or 30 a week; 4 grouse a day or 8 a week; 4 sage hens a day or 8 a week; 10 mountain quail a day or 20 a week; 15 valley or desert quail a day or 30 a week; 25 Wilson snipe or jacksnipe a day or 50 a week; 15 mourning doves a day or 30 a week; 25 ducks and 8 geese a day or 50 a week combined; 25 coots (mud hens) and gallinules a day, 50 coots a week; 8 honkers or black sea brant a day or 24 a week.

Possession in excess of daily limit prohibited. Persons killing deer must retain in possession during open season and 10 days thereafter the skin and the portion of head bearing horns.

One day's limit of game birds or animals may be possessed during first five days of close season.

Sale: Sale of deer meat and hides, tree squirrels, and all game birds prohibited.

Hides of deer lawfully killed when duly tagged under affidavit (fee 25 cents) may be sold August 1–December 31. Cottontail and brush rabbits may be sold. Domesticated reindeer may be imported and sold under regulations of fish and game commission.

Export: Export of all protected game prohibited, except for scientific or propagating purposes under permit from board of fish and game commissioners. All shipment by parcel post prohibited.

COLORADO.

Open seasons:	*Dates inclusive.*
Deer (having horns with two or more prongs)	Oct. 1–Oct. 4.
Rabbit, hare	Unprotected.
Prairie chicken, mountain and willow grouse	Sept. 15–Oct. 1.
Sage chicken	Aug. 15–Sept. 1.
Dove (one day only)	Sept. 1.
Duck, goose, brant, coot, gallinule, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31
Rail, other than coot and gallinule	Sept. 16–Nov. 30.

No open season: Elk, antelope, sheep, quail (bob-white crested), pheasant (1924); doe, partridge, ptarmigan, wild turkey.

Hunting and fishing licenses: Nonresident: Big game, $25; birds, $5; fish, $2. Resident: Big game, $2; small game and fish, $1. No person under 18 permitted to hunt big game. Fishing license not required of boys under 16 or of women. Children under 12 not permitted to hunt except on own premises or those of parent or guardian. Guide, $5 in addition to State hunting license. Issued by commissioner, county clerks, and other agents. Unlawful to hunt in any inclosure not public land without consent of owner. Unlawful to shoot game from public highway.

Bag limits and possession: One deer a season, coupon required; prairie chicken, sage hen, mountain and willow grouse, 10 in all a day, 15 in possession. Twenty-five doves, 20 ducks, 8 geese, 8 brant, 20 Wilson snipe, 20 in all of rails, coots, and gallinules, 15 in all of plovers and yellowlegs, but not more than 20 in all of migratory game birds a day, 35 in possession. Persons under 12 years of age limited to half this number of birds. Possession of rails permitted during first 10 days of close season; other game during first 5 days thereof. Commissioner may issue permit authorizing storage, possession, and use of upland game for 90 days after close of open season, and migratory birds for 10 days after close of season.

Sale: Sale of migratory game and of all other game taken in the State prohibited; provided imported game (except migratory birds) may be sold under license by indorsement of shipping invoice to purchaser.

Export: The export of all protected game is prohibited; provided birds, not exceeding the numbers allowed in possession, may be exported under permit from game commissioner (fee 25 cents for each bird) if permit be attached and packages plainly marked so as to show nature of contents, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week; edible portion of deer may be exported under $5 permit from commissioner.

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[1] *California:* Fishing licenses required of persons 18 years of age and over: Nonresident or alien, $3; resident, $1.

CONNECTICUT.

Open seasons:	*Dates inclusive.*
Deer.[1]	
Hare, rabbit (except Belgian or German hare, unprotected)	Oct. 8–Dec. 15.[2]
Gray squirrel, quail, cock pheasant (introduced), Hungarian partridge, woodcock	Oct. 8–Nov. 23.
Duck, goose, brant	Oct. 1–Jan. 15.
Coot (mudhen), gallinule	Oct. 1–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Nov. 30.
Wilson or English snipe	Oct. 1–Nov. 30.
Rail, other than coot and gallinules	Sept. 12–Nov. 30.

No open season: Dove; ruffed grouse (partridge), hen pheasant (introduced), (Oct. 8, 1920).

Hunting and fishing licenses: Nonresident: Game, $10.25; fish, $2.25.[3] Alien, $15.25. Resident citizen, $1.25. Not issued to persons under 16. Issued by city or borough clerk. No license required of resident and his children to hunt during open season on land on which he is actually domiciled if land is not used for club or shooting purposes.

Bag limits and possession: Six gray squirrels a day, 30 a season; 3 rabbits a day, 30 a season; 5 each of quail and woodcock a day, 36 each a season; 3 Hungarian partridges a day, 21 a season; 2 cock pheasants a day, 15 a season; 25 in all of ducks, geese, and brant, but not exceeding 8 geese and 8 brant a day; 10 in all of plover, yellowlegs, and Wilson snipe; 35 sora and 25 in all of other rails, coot, and gallinules a day, but not more than 35 in all of sora and other rails. Possession of rails permitted during first 10 days of close season.

Sale: Sale of squirrels, rabbits, and introduced pheasant permitted during open season. Sale of other game prohibited.

Export: Export of quail, ruffed grouse, and woodcock prohibited, provided a nonresident licensee under permit may take out in his immediate possession game lawfully killed, when duly tagged, if not for sale; but not more than two days' limit of migratory birds shall be exported in any one calendar week.

DELAWARE.

Open seasons:[4]	*Dates inclusive.*
Rabbit, hare, quail, partridge, woodcock	Nov. 15–Dec. 31.
Squirrel (fox, black, gray)	Sept. 15–Nov. 1.
Dove (except in Newcastle County, no open season)	Nov. 15–Dec. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Rail, other than coot and gallinule	Sept. 1–Nov. 1.
Reedbird	Sept. 1–Oct. 30.[5]

No open season: Hungarian partridge or pheasant.

Hunting and fishing licenses: Nonresident: Game, $10.50; fish, $3.50 (not good in Delaware River or Bay). Issued by commission. Unlawful to hunt on land of another without permission from owner or occupant. Fishing license not required of certain excursionists. Nonresidents who own or lease property at seaside summer resorts and their relatives, friends, and patrons sojourning at such resorts may fish for nongame fish and hunt without license during open season, between June 1 and September 30.

Bag limits and possession: Six in all of rabbits, hares, and squirrels, 20 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 50 sora, 25 in all of other rails, coots, and gallinules, but not more than 50 in all of sora and other rails combined; 12 birds of any other species (except reedbirds) a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

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[1] *Connecticut:* Owner of agricultural lands, member of family, or employee may kill deer with a shotgun at any time on such lands when damaging fruit trees or growing crops, but such killing or wounding must be reported to the commissioners within 12 hours.

[2] Between Nov. 24 and Dec. 15 hunting rabbits is permitted with dog and ferret only.

[3] Required only of residents of States which require a nonresident to obtain an angling license. Not required of nonresident taxpayer or member of his family, nor of persons under 16 years of age.

[4] *Delaware:* Minors under 15 years of age not permited to hunt game with shotgun or rifle unless accompanied by an adult lawfully hunting.

[5] See order of Secretary of Agriculture, p. 77.

Sale: Sale of reedbirds and all protected game prohibited: Provided a resident may sell in his own county 20 rabbits a season, lawfully taken by him. Imported rabbits may be sold from November 15 to December 31.

Export: Export of rabbit, squirrel, quail, partridge, dove, woodcock, goose, and brant is prohibited, provided holder of license may export, open to view, 10 rabbits, 10 squirrels, 50 rails, and 20 birds or fowl of any other species a week, lawfully killed by himself, under affidavit that the game is not for sale. Resident may export ducks, snipe, and plover. In no event, however, shall a person export more than 2 days' limit of migratory birds in any one calendar week. Under permit (fee, $1) of board 10 pairs of any one species of game or birds may be captured or transported.

DISTRICT OF COLUMBIA.[1]

Open seasons:	*Dates inclusive.*
Deer meat (sale or possession)	Sept. 1–Jan. 1.
Rabbit (except English rabbit, Belgian hare), squirrel	Nov. 1–Feb. 1.
Quail or partridge	Nov. 1–Mar. 15.
Ruffed grouse or pheasant (except English or other imported pheasants raised in inclosures, sale or possession unrestricted), wild turkey	Nov. 1–Dec. 24.
Prairie chicken (pinnated grouse)	Sept. 1–Mar. 15.
Marsh blackbird	Sept. 1–Feb. 1.
Duck, goose, brant, Wilson snipe, coot, gallinule	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs, rail or ortolan	Sept. 1–Nov. 30.
Woodcock	Nov. 1–Dec. 31.
Reedbird	Sept. 1–Oct. 30.[2]

No open season: Dove.

Bag limits and possession: Twenty-five ducks, 8 geese, 8 brant, 25 Wilson snipe, 6 woodcock, 50 sora, 25 in all of other rails, coots, and gallinules, 15 in all of plovers and yellowlegs a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of reedbirds and all migratory game birds prohibited. Other game may be sold during respective open seasons.

Export: Export of migratory game birds in excess of two days' bag limit in any one calendar week prohibited.

FLORIDA.

Open seasons:	*Dates inclusive.*
Deer, squirrel, quail (bobwhite partridge), wild turkey	Nov. 20–Mar. 1.
Ruffed grouse, imported pheasants	Nov. 20–Dec. 19.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, coot, gallinules, dove	Nov. 20–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinules	Nov. 20–Nov. 30.
Reedbird (rice bird)	Aug. 16–Nov. 15.[2]

Hunting licenses: Nonresident or alien, $15; resident, $1 (county of residence); resident, $3 (county other than county of residence). License not required in voting precinct nor of Confederate veteran entitled to a State pension. Issued by county judge.

Bag limits and possession: Three deer, 10 turkeys, and 300 of any other game birds a year; 1 deer, 2 turkeys, 20 quail, 25 ducks, 8 geese, 8 brant, 25 Wilson snipe, 6 woodcock, 25 in all of rails, coots, and gallinules, 15 in all of plovers and yellowlegs, and 25 doves a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: The sale of reedbirds (rice birds) and all protected game is prohibited.

Export: Export of all protected game is prohibited, except nonresident licensee may carry out game as personal baggage, but not more than two days' limit of migratory game birds shall be exported in any one calendar week.

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[1] *District of Columbia:* Hunting prohibited in the District by act of June 30, 1906, except on the marshes of the Eastern Branch above Anacostia Bridge and below the Aqueduct Bridge on the Virginia side of the Potomac, but in these areas no birds may be shot within 200 yards of any bridge or dwelling.

[2] *District of Columbia* and *Florida:* See order of Secretary of Agriculture, p. 77.

GEORGIA.

Open seasons:	*Dates inclusive.*
Deer	Oct. 1–Nov. 30.
Rabbit, fox squirrel	Unprotected.
Cat squirrel, opossum	Oct. 1–Feb. 29.
Quail, partridge, wild turkey gobblers	Nov. 20–Feb. 29.
Duck, goose, brant, coot, gallinule, Wilson snipe	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs, dove	Nov. 20–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinules	Sept. 1–Nov. 30.
Reedbird (ricebird)	Aug. 16–Nov. 15.[1]

No open season: Fawn, grouse, pheasant, turkey hen, introduced game birds.

Hunting licenses: Nonresident, $15; resident, State $3, county $1 (good only in county of residence). License not required in militia district or to hunt on own or leased land. Issued by commissioner or county warden.

Bag limits and possession: Two deer, 2 turkeys a season; 15 cat squirrels, 25 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 25 in all of rails, coot, and gallinules, 25 doves a day. Possession of migratory birds except woodcock permitted during first 10 days of close season.

Sale: Sale of reedbirds (ricebirds) and all protected game prohibited.

Export: Export of all protected game prohibited, provided, nonresident licensee may take out in personal possession game lawfully killed, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week.

IDAHO.

Open seasons:	*Dates inclusive.*
Elk in Bingham, Bonneville, Fremont, and Teton Counties	Sept. 16–Dec. 15.
In Clearwater and Idaho Counties	Oct. 1–Nov. 15.
In rest of State	No open season.
Deer, mountain goat in Adams, Blaine, Boise, Bonneville, Butte, Caribou, Clark, Custer, Elmore, Franklin, Gooding, Idaho, Jefferson, Lemhi, Lincoln, Madison, Power, Teton, Valley, and Washington Counties	Sept. 16–Nov. 30.
Deer, elk, mountain goat in game preserves and rest of State	No open season.
Quail in Ada, Cassia, Clearwater, Gem, Gooding, Idaho, Kootenai, Latah, Lewis, Lincoln, Nez Perce, and Owyhee Counties	Nov. 1–Nov. 15.
In rest of State	No open season.
Chinese, ringneck, and Mongolian pheasants in Ada, Canyon, Gem, Gooding, Latah, Lincoln, Nez Perce, and Twin Falls Counties	Nov. 1–Nov. 30.
In rest of State	No open season.
Partridge, pheasant, grouse in Benewah, Bonner, Boundary, Kootenai, and Shoshone Counties	Sept. 1–Oct. 31.
In Clearwater, Idaho, Latah, Lewis, and Nez Perce Counties	Aug. 15–Oct. 15.
Partridge or pheasant in Bannock, Bear Lake, Bingham, Bonneville, Butte, Caribou, Franklin, Fremont, Jefferson, Madison, Oneida, Power, and Teton Counties	Aug. 15–Sept. 15.
Ruffed and blue or dusky grouse in Adams, Bannock, Bingham, Blaine, Boise, Bonneville, Butte, Camas, Custer, Elmore, Franklin, Fremont, Idaho, Lemhi, Madison, Teton, Valley, and Washington Counties	Aug. 15–Sept. 30.
Grouse (all kinds) in Ada, Canyon, Cassia, Clark, Gem, Gooding, Jerome, Lincoln, Minidoka, Owyhee, Payette, and Twin Falls Counties	No open season.
Franklin grouse (fool hen), sharp-tailed grouse (prairie chicken), south of line between townships 24 and 25 north, range 2 west, Salmon River and north boundary line Lemhi County	No open season.
Sage hen (State)	Aug. 15–Sept. 30.
Doves	Sept. 1–Sept. 30.
Duck, goose, brant, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs, coot, and gallinule	Sept. 16–Dec. 31.
Rail other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Moose, antelope, caribou, sheep, buffalo, fawn, calf elk, prairie chicken, pinnated grouse (except as above), and imported pheasants (except Chinese, ringneck, and Mongolian pheasants as above).

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[1] *Georgia:* See order of Secretary of Agriculture, p. 77.

Hunting and fishing licenses: Nonresident:[1] Game and fish, $10; bird, $5; fish, $2. Alien: Game and fish, $50; fish, $10. Resident: Game and fish, $1.50. Issued by warden, deputy, or authorized agent. Fishing license not required of children under 12 or of women. No license required of resident women or of veterans of Civil War. Persons under 12 prohibited possessing gun afield.

Bag limits and possession: One deer, 1 elk, 1 goat a season; 8 quail, 4 in all of Chinese, ringneck, and Mongolian pheasants; 6 in all of partridge, pheasant, grouse, and sage hen, and 12 mourning doves, a day or in possession; 18 ducks, 2 geese, 6 black-bellied and golden plovers, 6 yellowlegs, 12 Wilson snipe, or a total of 20 in all a day or in possession; 50 sora and 25 in all of other rails, coots, and gallinules a day.

Sale: Sale of all protected game prohibited. Hides, heads, and horns may be sold under permit.

Export: Export of all protected game is prohibited, provided any hunter may export, under hunting license coupon, big game lawfully taken; big game once shipped within State may be exported under a 50-cent permit obtained from game warden. Mounted heads and stuffed birds legally secured may be exported.

ILLINOIS.

Open seasons:	*Dates inclusive.*
Rabbit	Nov. 1–Jan. 31.
Squirrel	July 1–Dec. 1.
Quail (bob-white)	Nov. 10–Dec. 10.
Prairie chicken	Oct. 20–Oct. 31.
Introduced pheasant (cocks)	Oct. 1–Oct. 5.
Dove	Sept. 1–Sept. 30.
Duck, goose, brant, Wilson snipe, coot, gallinules, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer (1925); wild turkey, introduced pheasant hen, sand grouse (1925); ruffed grouse (partridge), blue, mountain, and valley quail, Hungarian partridge, capercailzie, heath hen, black grouse, woodcock (1923).

Hunting licenses: Nonresident or alien, $10.50; resident, $1. Licenses not issued to minors under 16 without written consent of parent or guardian. Issued by village, county, or city clerk. Owners, their children, and tenants in actual residence may hunt during open season on own land without license. Permission required to hunt on lands of another.

Bag limits and possession: Ten squirrels, 15 rabbits, 12 quail, 3 prairie chickens, 2 cock pheasants, 15 doves, 15 in all of black-bellied and golden plovers and yellowlegs, 15 snipe, 15 in all of coot and gallinules, 15 rail, but not more than 25 in all of rails, coots, and gallinules, 15 ducks, 8 geese, 8 brant a day. Limit in possession, 20 squirrels, 36 quail, 12 prairie chickens, 6 cock pheasants, 25 doves, 50 black-bellied and golden plovers and yellowlegs, 50 snipe, 60 coots and gallinules, 60 rail, 60 ducks, 10 geese, 10 brant.

Sale: Sale of all protected game (except rabbit during open season) prohibited.

Export: Export of all protected game (except rabbit) prohibited, except nonresident licensee may take from State 50 game birds or animals, if carried openly for inspection, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week.

Holder of certificate may ship birds and game at any time for scientific or propagating purposes. (See Regulation 8, p. 74.)

INDIANA.

Open seasons:	*Dates inclusive.*
Rabbit	Apr. 1–Jan. 10.
Squirrel	Aug. 1–Dec. 1.
Quail, ruffed grouse	Nov. 10–Dec. 20.
Prairie chicken	Oct. 15–Nov. 1.
Duck, goose, brant	Sept. 16–Dec. 31.
Woodcock	Oct. 15–Nov. 1.
Black-bellied and golden plovers, yellowlegs, Wilson or jack snipe, coot, gallinule	Sept. 16–Dec. 20.
Rail, other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Deer, Hungarian partridge, introduced pheasant, wild turkey, dove.

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[1] *Idaho:* Residents of States adjoining Idaho having larger nonresident license fee must pay fee charged in own State.

Hunting and fishing licenses: Nonresident: Game and fish, $15.50; fish, $1. Resident, $1. Issued by clerk circuit court. Not issued to person under 14 without written consent of parent or guardian. Civil War veterans, owners of farm land, their children living with them, and tenants may hunt during open season on own land without a license. No license required of persons to fish in county of residence or contiguous counties. Wife of licensee and children of licensee under 18 may fish without license.

Bag limits and possession: Fifteen quail, 5 prairie chickens, 15 ducks, 8 geese, 8 brant a day; 45 waterfowl in possession as result of 3 or more days' consecutive hunting; 25 Wilson snipe, 6 woodcock, 50 sora, and 25 in all of other rails, coots, and gallinules, and 15 in all of plovers and yellowlegs a day. Possession of waterfowl permitted during first 10 days of close season.

Sale: Sale of quail, prairie chicken, introduced pheasants, Hungarian partridges, and migratory birds prohibited.

Export: Export of deer, quail, grouse, prairie chicken, pheasant, wild turkey, woodcock, duck, goose, brant, and other waterfowl prohibited, except nonresident may take from State 15 birds killed by himself (or 45 if he has hunted for 3 or more days consecutively) if carried openly for inspection together with license, but not more than two days' limit of migratory birds shall be exported in any one calendar week.

Miscellaneous: Shooting on highways prohibited.

IOWA.

Open seasons:	*Dates inclusive.*
Squirrel (gray, timber, or fox)	Sept. 1–Jan. 1.
Ruffed grouse or pheasant, wild turkey	Nov. 1–Dec. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Nov. 30.
Rail other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer, elk, quail, prairie chicken, introduced pheasants, Hungarian partridge (1922); turtle dove.

Hunting and fishing licenses: Nonresident or alien, game, $10; nonresident, fish, $2 (required of males over 16 years of age). Resident citizen, $1. Issued by county auditor. Licenses not granted to persons under 18 without written consent of parent or guardian. Owners of farm lands, their children, and tenants, may hunt on own lands during open season without license. Unlawful to hunt on cultivated or inclosed lands of another without permission from owner.

Bag limits and possession: Twenty-five ducks a day, 50 in possession; 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 25 in all of rails, coots, and gallinules a day, 25 of each in possession. Twenty-five each of other birds and game a day or in possession. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except nonresident may take from State not more than 25 game birds or animals, if carried openly for inspection, and if hunting license be shown on request, but not more than two days' limit of migratory birds shall be exported in any one calendar week.

KANSAS.

Open seasons:	*Dates inclusive.*
Fox squirrel	Sept. 1–Jan. 1.
Quail	Dec. 1–Dec. 10.
Duck, goose, brant, Wilson snipe, coot, gallinules, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Nov. 30.
Rail other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Deer, antelope (1925); red, gray, and black squirrels, prairie chicken, ruffed grouse (partridge), pheasant (English, Mongolian, Hungarian) (1924); doves.

Hunting licenses: Nonresident, $15. Issued by secretary of state. Resident, $1. Issued by county clerk. Issued free to honorably discharged soldiers or sailors of United States. Resident landowner or member of family may hunt on own land during open season without a license. Unlawful to hunt on land of another or on highway or railroad right of way adjacent thereto without written consent of owner, unless accompanied by him.

Bag limits and possession: Twenty ducks, 10 quail, 12 Wilson snipe, 6 each of woodcock, geese, and brant, 50 sora and 25 in all of other rails, coots, and gallinules, and 15 in all of plovers and yellowlegs a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of all protected game birds prohibited.

Export: Export of all protected game birds prohibited.

KENTUCKY.

Open seasons:	*Dates inclusive.*
Rabbit [1]	Nov. 15–Dec. 31.
Squirrel	July 1–Dec. 15.
Quail	Nov. 15–Jan. 1.
Dove	Sept. 1–Oct. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinules, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Rail other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Deer, elk (1921); native and introduced pheasants, Hungarian partridge, wild turkey (1920); woodcock.

Hunting licenses: Nonresident or alien, $7.50. Resident, $1. Issued by county clerk. Resident land owner, tenant, and members of families may hunt on own land during open season without license. Unlawful to enter inclosed lands of another for shooting, hunting, or fishing without consent.

Bag limits and possession: Twelve quail a day, 12 in possession for each day of hunt; 15 doves a day, 15 in possession for each day of hunt; 25 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 50 sora, and 25 in all of other rails, coot, and gallinules a day. Possession of migratory birds, except doves, permitted during first 10 days of close season.

Sale: Sale of quail, partridge, grouse, introduced or native pheasant, Hungarian partridge, wild turkey, and migratory birds, wherever killed, prohibited.

Export: Export of deer, elk, and all game birds prohibited, except a hunter may transport game lawfully killed and possessed by him, but more than 2 days' limit of migratory birds shall not be exported in any one calendar week.

LOUISIANA.

Open seasons:	*Dates inclusive.*
Deer (see exception)	Sept. 15–Jan. 5.[2]
Exception: South of Vernon, Rapides, Avoyelles, and Concordia Parishes, and Mississippi State line	Oct. 1–Jan. 20.
Bear	Nov. 1–Feb. 15.[3]
Squirrel	Sept. 15–Feb. 15.
Dove	Sept. 16–Dec. 31.
Quail	Nov. 15–Feb. 29.
Wild turkey	Nov. 15–Mar. 31.
Gros-bec (night heron)	July 1–Oct. 31.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, rails, coot, gallinules	Nov. 1–Jan. 31.

No open season: Fawns, elk, prairie chicken, introduced pheasant, upland plover (papabotte) (1922); woodcock (1923).

Hunting licenses: Nonresident or alien, $15; resident, $1. Issued by tax collectors. Nonresident or alien not permitted to hunt for profit. A person may hunt during open season without a license on land owned or leased for agricultural purposes. License does not authorize hunting on land of another without his written consent.

Bag limits and possession: Two deer a day or in possession, 5 a season; 15 squirrels, 15 quail, 1 turkey, 25 doves, 25 ducks; 8 geese, 8 brant, 10 in all; 25 in all of rails, coots, and gallinules; 15 gros-becs; 15 in all of plovers and yellowlegs; 25 Wilson snipe and 15 other birds in all a day. Possession permitted during first five days of close season.

Sale: Sale of all protected game (except squirrels during open season) prohibited.

Export: Export of all protected game prohibited, except under permit for scientific or educational purposes; provided, a nonresident licensee may carry with him out of the State under his license one day's limit of game, if not for sale. Bears shall not be exported, except under written permission of conservation department.

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[1] *Kentucky:* Rabbits may be taken with dogs or snares at any time for a person's own use on own land, but not for sale or barter.

[2] *Louisiana:* Deer season fixed by conservation commissioner.

[3] Nonresidents coming into State to hunt bears must report in writing to conservation department before arrival at destination.

MAINE.[1]

Open seasons:[2]	*Dates inclusive.*
Deer (see exception)	Oct. 1–Nov. 30.
Exception: In Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties	Nov. 1–Nov. 30.
Bull moose	Nov. 21–Nov. 30.
Hare, rabbit	Oct. 1–Mar. 31.
Gray squirrel	Oct. 1–Oct. 31.[3]
Ruffed grouse, partridge, woodcock (see exception)	Oct. 1–Nov. 30.
Exception: In Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties	Oct. 1–Oct. 31.
Duck, goose, brant, Wilson snipe, coot, gallinules	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Rail, other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Deer on Cross, Scotch, Swan, and Mount Desert Islands, and in towns of Deer Isle and Stonington, in Hancock County, and in Isle au Haut, in Knox County, cow and calf[4] moose, caribou, quail, Hungarian partridge, pheasant, black game, capercailzie, cock of the woods, dove.

Hunting and fishing licenses: Nonresident hunting licenses: Moose, $25; deer and other game, October 1–December 31, $15; birds, prior to October 1 in Aroostook, Franklin, Hancock, Oxford, Penobscot, Piscataquis, Somerset, and Washington Counties, $5; season (except November) in rest of State, $5. For November, a $15 license, or, if moose are to be hunted, a $25 license is required. Holder of a license may exchange it for a license for which a larger fee is required by paying the difference in price. Nonresident must be accompanied by registered guide when camping and kindling fires while hunting or fishing on wild lands (land in unorganized or unincorporated townships) prior to November 30. Nonresident or resident alien, fishing license, $2.15 (not required of children under 14 years of age). Resident alien, game, $15 (not required of aliens who pay taxes on real estate and who have resided in State two years continuously prior to application). Guide licenses: Nonresident, $20; resident, $1. Must not guide more than five persons hunting at one time. Shipping licenses (within State): Resident, deer, $2; one pair of game birds in seven days, 50 cents. Issued by commissioner.

Resident hunting license, fee 25 cents. Not required of resident or member of immediate family for hunting during open season on own land used exclusively for agricultural purposes and on which he is actually domiciled. License valid as long as holder remains citizen of State. Issued by city, town, and plantation clerks.

Bag limits and possession: Two deer (except in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties, limit 1), 1 bull moose a season, 5 ruffed grouse, 10 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs but not more than 5 plovers, 10 Wilson snipe, 6 woodcock, 50 sora and 25 in all of other rails, coot, and gallinules a day. Transportation of migratory game birds must be completed within five days after close of season; reasonable time allowed after close of season to transport other game to home of owner. Possession of migratory birds limited to first 10 days of close season; deer legally secured may be possessed during close season.

Sale: Sale of all protected game birds prohibited; sale of bull moose or deer for export prohibited. Local provision dealer, under $5 license, may purchase 2 deer and 1 bull moose for retail to his customers. Deerskins and skins with heads attached may be bought and sold by residents under $25 license. Heads when detached from skins with which purchased may be sold to licensed taxidermists.

Export: Export of all protected game prohibited, provided a resident of the State, under shipping license, may export 5 partridges, 10 woodcock, and 10 ducks (fee $5) lawfully killed by himself. A nonresident may export, open to view under hunting-license tags, 2 deer and 1 bull moose, if lawfully killed by himself, plainly labeled with name and address of owner, accompanied by him, and identified at points designated by commissioner, and under bird-hunting license may take home 5 partridges, 10 ducks, and 10 woodcock lawfully killed by himself; nonresident licensee may also ship out one pair of game birds a month under a special 50-cent license. Live game may be exported for breeding and advertising purposes under permit of the commissioner of inland fisheries and game.

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[1] *Maine:* Commissioner may make local regulations and governor may suspend hunting seasons during drought.

[2] All hunting is prohibited on Kineo Point, Piscataquis County; on Back Bay above Grand Trunk Railroad bridge, and on Richmonds Island, Cumberland County; southern point Swan Island; and locally in town of Eden, Hancock County, and town of Scarboro, Cumberland County. (See State laws for details and other protected areas.)

[3] Squirrels protected in parks and in compact or built-up portions of cities and villages.

[4] Term applies to animals under 1 year of age and which do not have at least two 3-inch prongs to each horn.

Miscellaneous: Unlawful to possess rifle or shotgun, either loaded or with a cartridge in the magazine thereof, in or on any motor vehicle while upon any highway or in the fields or forests.

MARYLAND.

Open seasons:		*Dates inclusive.*
Rabbit (see exception)		Nov. 10–Dec. 24.
Exception: In Dorchester, Nov. 10–Jan. 1.		
Squirrel (see exceptions)		Aug. 25–Oct. 1. Nov. 10–Dec. 24.
Exceptions: In Allegany County	Sept. 15–Dec. 24.	
In Cecil	Aug. 25–Oct. 25.	
In Dorchester	Sept. 1–Jan. 1.	
In Frederick	Aug. 25–Dec. 24.	
In Anne Arundel, Calvert, Charles, Prince George, and Talbot	Nov. 10–Dec. 24.	
In St. Mary	Unprotected.	
Quail, ruffed grouse, wild turkey, introduced pheasant, woodcock (see exceptions)		Nov. 10–Dec. 24.
Exceptions: Quail in Dorchester, Nov. 10–Jan. 1; quail in Frederick (1921); ringneck or English pheasant in Baltimore County (1920); ruffed grouse, ringneck pheasant, wild turkey in Harford (no open season); ruffed grouse, introduced pheasants in Wicomico (1921); introduced pheasants and partridges, ruffed grouse in Dorchester (1920); woodcock in Anne Arundel (no open season).		
Dove		Sept. 1–Dec. 15.
Duck, goose, brant, Wilson snipe, coot, gallinules		Nov. 1–Jan. 31.[1]
Black-bellied and golden plovers, yellowlegs		Aug. 16–Nov. 30.[1]
Rail, other than coot and gallinules		Sept. 1–Nov. 1.
Reedbirds		Sept. 1–Oct. 30.[2]

No open seasons: Deer, elk (1922).

Hunting licenses: Nonresident, $10.25 (fee $5.25 for State license if applicant owns real estate in Maryland assessed at $500; $1.25 for county license in county where such real estate is located); resident, State, $5.10; county, $1.10; issued by clerks of circuit court—in Baltimore city by clerk court common pleas. License not issued to person under 14 years of age without written request of parent or guardian. Owners, tenants, and their children may hunt on own land during open season without license. Patuxent River Club license, $25; issued by clerk of circuit court. Aliens not permitted to hunt or possess firearms. Unlawful to hunt on lands of another without written permission of owner or tenant.

Sinkbox, sneak boat, blind, pusher.—Cecil: Sneak boat (Bohemia and Elk Rivers), $5.50; sinkbox (Bohemia, Elk, and Sassafras Rivers), $10.50. *Anne Arundel:* Pusher, $2; booby and brush blinds (west side Chesapeake Bay), $5; (South River), $2.50. *Harford:* Sinkbox, $20.75; sneak boat, $5.75. *Kent:* Sinkbox, $20; blind, $5. *Queen Anne:* Sinkbox, $10:50; sneak boat, $5.75; booby blind, $2.50. *Susquehanna Flats:* Sinkbox, $20.75; sneak boat, $5.75; *Talbot:* Sinkbox, $5; blind or sinkbox (Dickson Bay), $5. *Patuxent River:* Pusher, $2.50 (required of residents to push or paddle nonresidents).

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[1] *Maryland:* Wild fowl shooting restricted locally as follows: On the Susquehanna flats north of a line extending from Turkey Point Lighthouse, Cecil County, and half a mile north of Spesutia Island to Oakington, Harford County, hunting allowed only on Mondays, Wednesdays, and Fridays, Nov. 1–Jan. 1, and Mondays, Wednesdays, Fridays, and Saturdays, Jan. 1–Jan. 31; in Harford County only before 2 p. m.; in Anne Arundel County, on Magothy River on Tuesdays, Thursdays, and Saturdays; on Rhode and West Rivers on Mondays, Wednesdays, and Fridays; on Severn River on Mondays, Wednesdays, and Saturdays; in Cecil County, on Bohemia, Elk, and Sassafras Rivers on Mondays, Wednesdays, Fridays, and Saturdays; in Dorchester County, on Choptank River on Tuesdays, Thursdays, and Saturdays; in Kent County, on Chester River above Cliff City and Spaniard Point on Mondays, Fridays, and Saturdays.

[2] See Order of the Secretary of Agriculture, p. 77.

Bag limits and possession: Four wild turkeys a season; 10 rabbits, 10 squirrels, 12 quail (partridge), 2 ruffed grouse, 3 English pheasants, 6 woodcock, 12 doves, 10 jacksnipe, 15 yellowlegs, 5 black-bellied plover, 15 golden plover (but not more than 15 plovers and yellowlegs combined), 50 reedbirds, 50 sora, 25 in all of other rails, coots, and gallinules (but not more than 10 coots and gallinules or 50 sora and other rails combined), 25 waterfowl (but not more than 8 geese and 8 brant) a day for each licensed gunner (not exceeding 4) connected with an outfit. Possession of waterfowl, Wilson snipe, and plovers permitted during first 10 days of close season, and of doves until December 24.

Additional county restrictions: Allegany, 2 wild turkeys a day. Baltimore, 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 1 English pheasant, 1 ringneck pheasant, 1 wild turkey a day. Calvert, 6 rabbits a day. Cecil, 5 rabbits, 6 squirrels, 50 blackbirds a day. Frederick, 8 rabbits, 5 woodcock a day. Garrett, 3 ruffed grouse, 3 English pheasants, 6 other game birds a day. Harford, 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 5 woodcock, a day or in possession.

Sale: Sale of reedbirds and all migratory game birds prohibited. The sale of game is further prohibited under county laws, as follows:

Allegany—Deer, squirrel, hare, quail, grouse, introduced pheasant, wild turkey, dove, woodcock.
Anne Arundel—All game (except squirrel, rabbit, and raccoon).
Baltimore—Rabbit, squirrel, quail, ruffed grouse, dove, pheasant, for export.
Calvert—Rabbit, quail, for export for sale.
Carroll—Squirrel, partridge, pheasant, dove, woodcock.
Cecil—All protected game (except rabbit).
Dorchester—Rabbit, squirrel, quail, partridge, for export.
Frederick—Rabbit, squirrel, partridge, pheasant, taken in county.
Garrett—Partridge, quail, pheasant, wild turkey, for export.
Harford—Rabbit, squirrel, quail (for sale).
Montgomery—Rabbit, quail, partridge, for export.
Somerset—Rabbit, quail or partridge, dead or alive, for any other purpose than as food within the county or for propagation; or any game for export.
Washington—All game.
Wicomico—Quail or partridge for export (Wicomico and Worcester Counties considered as one territory).
Worcester—Rabbit, quail (except to consumer).

Export: Export of all protected game (except waterfowl) prohibited; provided: a licensed hunter may take out under his license an amount equal to one day's bag limit of game, if not for sale.

County provisions prohibiting export are as follows:

Allegany—All protected game (for sale).
Anne Arundel—All protected game, viz: Squirrel, rabbit, quail, partridge, pheasant, woodcock, snipe, plover, duck, goose, brant from county.
Baltimore—Rabbit, squirrel, quail, partridge, pheasant, dove, woodcock from county.
Calvert—Rabbit, partridge, woodcock from county (for sale, barter, or trade).
Carroll—Squirrel, quail, pheasant, dove, woodcock.

Exception: Twelve squirrels, 10 quail, 3 pheasants, 12 doves, 6 woodcock, by guest of landowner or nonresident licensee as personal baggage and not for sale.

Caroline—Rabbit, quail, partridge, woodcock from county.
Cecil—Squirrel, quail, grouse, woodcock, plover from county.
Dorchester—All protected game.

Exception: Twelve quail or partridges, 6 each of squirrels, rabbits, woodcock, and doves may be taken out of the county at one time as personal baggage, if carried openly and not intended for sale.

Frederick—Rabbit (for sale), squirrel, partridge, pheasant, woodcock from county (for sale).
Garrett—Partridge, pheasant, wild turkey, woodcock from State.

Exception: Rabbit, if shipped openly, Nov. 10–Dec. 25. Nonresident may take out game killed under his hunting license.

Harford—Rabbit, squirrel, quail.

Exception: Nonresident licensee may take out 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 5 woodcock, 10 jacksnipe, 50 rail for private use.

Kent—Squirrel, rabbit, and all birds from county (for sale, except under license).
Montgomery—Rabbit, partridge, quail, woodcock from county (for sale).

Exception: Nonresident licensee may take out game lawfully killed.

Queen Anne—Rabbit, partridge, woodcock from county (for sale).
Somerset—All game, viz: Squirrel, rabbit, quail or partridge, pheasant, dove, woodcock, duck, goose from county.

Talbot—All game.

Exception: Six rabbits, 6 squirrels, 12 quail, 6 doves, 6 woodcock may be taken out if not for sale.

Washington—Deer, squirrel, rabbit, partridge, pheasant, dove, woodcock, turkey from county (for sale).

Wicomico—Quail or partridge, Wicomico and Worcester Counties considered as one territory.

Worcester—Rabbit, quail, woodcock from county.

MASSACHUSETTS.

Open seasons:[1]	*Dates inclusive.*
Deer (first Monday in December to the following Saturday, inclusive)	Dec. 1–Dec. 6.
Hare or rabbit (see exceptions)	Oct. 20–Feb. 28.
Exceptions: Hare or white rabbits in Bristol and Norfolk Counties, 1920; European hares in Berkshire County, unprotected.	
Gray squirrel, quail, woodcock (see exception)	Oct. 20–Nov. 20.
Exception: Quail in Dukes, Essex, Hampden, Middlesex, and Nantucket Counties (1922).	
Introduced pheasant (see exception)	Oct. 20–Nov. 20.
Exception: In Dukes County	No open season.
Duck, goose, brant, Wilson snipe, gallinules, quark (mudhen)	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Rail, other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Moose, dove, prairie chicken, Hungarian partridge, pheasants (English, golden, Mongolian),[2] heath hen; ruffed grouse (1920).

Hunting and fishing[3] licenses: Nonresident citizen: General, $10; fish, $1. Members of incorporated game clubs owning real estate assessed at not less than $500 for each member, and which were organized prior to 1907; owners, or their minor children over 18 years old, of real estate assessed at not less than $500; or nonresidents invited (for not more than four days) by members of incorporated club for hunting foxes pay a fee of $1. Resident citizen: General, $1; fish, 50 cents. License not issued to minors under 15, and those under 18 years of age must apply in writing and furnish written consent of parent or guardian. Trapping license, in discretion of issuing officer, may be issued to any minor. License not required of resident for hunting on own land used exclusively for agricultural purposes and on which he is actually domiciled, nor of women or minors under 18 to fish. Alien: General, $15; fish, $1 (applicant must own real estate to the assessed value of $500). Issued by city or town clerks.

Bag limits and possession: One deer, 15 gray squirrels, 20 woodcock, 20 quail a season; 5 gray squirrels, 4 woodcock, 4 quail a day; pheasants, 2 a day, 6 a season; 25 ducks (not more than 15 black ducks), 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 50 sora, and 25 in all of other rails, coots, and gallinules a day. Possession of waterfowl in counties of Barnstable, Bristol, Dukes, and Nantucket, and of plovers, yellowlegs, and rails permitted during first 10 days of close season.

Sale: The sale of all game (except hare and rabbit) is prohibited; provided, deer, moose, caribou, and elk lawfully killed and imported into the State under warden's tag may be sold under license at any time. Dealers may sell under license unplucked bodies of pheasant, Scotch grouse, European black game, red-legged partridge, and Egyptian or migratory quail imported from without the United States. The above game must be tagged; fee, 5 cents a tag. Hares or rabbits lawfully secured may be sold at any time. Live quail under State permit and waterfowl under Federal and State permits may be sold for propagation.

Export: Export of quail and ruffed grouse taken in State and of all migratory game birds prohibited; provided, a nonresident under his license may take 10 in all of wild fowl and quail into another State according similar privilege, if carried open to view and the commission or district deputy is notified; provided further, a resident may export all game (*except* quail, ruffed grouse, woodcock), but more than two days' bag limit of migratory birds shall not be exported in any one calendar week. No game illegally taken shall be exported.

Miscellaneous: Deer may be taken with a shotgun only. Unlawful to hunt or kill game with rifle or revolver during open season for deer.

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[1] *Massachusetts:* Governor may suspend open seasons during extreme drought.

[2] Commission may open season on pheasants.

[3] License required to fish in inland waters which have been stocked with fish by the commission since January 1, 1910.

MICHIGAN.

Open seasons: [1]	*Dates inclusive.*
Deer (see exceptions)	Nov. 10–Nov. 30.
Exceptions: Deer in red coat, fawn in spotted coat; all deer in Bay, Clare, Emmet, Gladwin, Huron, Lake, Midland, Missaukee, Newaygo, Oceana, Ogemaw, Osceola, Otsego, Roscommon, Tuscola Counties (1923).	
Rabbit (see exception)	Oct. 1–Mar. 1.
Exception: South of township 21 north	Nov. 1–Mar. 1.
Squirrel (fox)	Oct. 15–Oct. 31.
Ruffed grouse (partridge) (see exception)	Oct. 1–Oct. 31.
Exception: Lower Peninsula	Nov. 1–Nov. 30.
Woodcock	Oct. 1–Nov. 25.
Duck, goose, brant, Wilson snipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 15.
Rail	Sept. 16–Nov. 30.

No open season: Elk, moose, caribou, European partridge, dove, squirrel (except fox squirrel), quail, introduced pheasants, black game, capercailzie, hazel grouse, Canada or spruce grouse, prairie chickens, wild turkey (1921).

Hunting licenses: [2] Nonresident or alien: Deer, $25; small game, $10. Resident: Deer, $1.50; small game, $1. Issued by county clerks, commissioner, or deputy. Export, issued by commissioner, $10. Licenses issued to persons under 17 and over 12 on application of parent or guardian, who must accompany such minor when hunting. No license required of residents or minor children hunting small game on own inclosed land on which they reside.

Bag limits and possession: One deer a season, 5 partridge a day, 10 in possession, 25 a season; 25 ducks and coots a day or in possession, 50 a calendar week; 6 geese and brant a day or in possession, 25 a season; 6 woodcock a day, 20 in possession, 25 a season; 15 Wilson snipe a day, 25 a season; 15 in all of black-bellied and golden plovers and yellowlegs a day, 25 a season; 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season, ruffed grouse (partridge) during first 30 days of close season, and other game during first 5 days thereof. Camping party of six or not less than four licensed hunters maintaining a camp of not less than four persons for not less than seven days may, under permit (fee $3), kill one deer for camp purposes.

Sale: Sale prohibited of all protected game, except rabbit, provided deer skins and green or mounted buck-deer heads lawfully taken may be sold under permit. Dealers may sell under license unplucked carcasses of pheasants of all species, Scotch grouse, European black game, red-legged partridge, Egyptian quail, European red deer, fallow deer, roe buck, and reindeer lawfully imported from another State or country, if properly tagged on arrival in State. Licensed retail dealer, club, hotel, restaurant, etc., may sell portion of said imported and tagged game to patron or customer for actual consumption or use.

Export: Export prohibited of all protected game.

Exceptions: (1) Deer may be transported outside the State to reach a point within the State.

(2) Nonresident licensee may take out, as hand baggage, open to view, 1 day's bag limit of birds, and may ship one deer when license tag and seal are attached, if permit on back of license coupon is canceled by agent at initial point of billing.

(3) Landowners and members of clubs owning game preserves may take out as hand baggage during open season under a $10 permit from State warden 20 ducks or other migratory birds killed by them on their own premises, but not more than two days' limit of migratory birds shall be exported in any one calendar week.

(4) Deer skins and green or mounted buck-deer heads may be exported under permit.

MINNESOTA.

Open seasons: [3]	*Dates inclusive.*
Deer, bull moose	Nov. 15–Dec. 5.
Black bear, rabbit (see exception)	Unprotected.
Exception: Varying hare, or snowshoe rabbit, and jack rabbit	Oct. 15–Mar. 1.
Squirrel	Oct. 15–Mar. 1.[4]

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[1] *Michigan:* Seasons may be shortened or closed by order of commissioner.

[2] Fishing licenses: Nonresident (males over 21), general, $5 (after Jan. 1, 1920, fee $3); special, $1 (fish, except brook trout).

[3] *Minnesota:* All hunting prohibited within 3 miles of the corporate limits of Duluth, Minneapolis, and St. Paul.

[4] Squirrels protected within corporate limits of any city or village, or within one-fourth mile thereof.

Open seasons—Continued.	*Dates inclusive.*
Quail	Oct. 15–Nov. 30.
Duck, goose, brant, coot, gallinules, Wilson snipe or jacksnipe, yellowlegs	Sept. 16–Nov. 30.
Rail	Sept. 16–Dec. 31.

No open season: Elk, cow moose, caribou, imported pheasants, woodcock, upland plover, dove, and ruffed grouse (1920), prairie chicken, pinnated, white-breasted, and sharp-tailed grouse (1922); black-bellied and golden plovers.

Hunting and fishing licenses: Nonresident or alien: Animals, $50; birds, $15; issued by commissioner. Fishing license, $1 (not required of person under 16 years of age). Issued by commissioner, county auditors, game wardens, and agents. Resident: Animals, $1; birds, $1; fish, $1. Issued by county auditor. Not issued to person under 14 years of age. Owners, lessees, or members of their immediate families may hunt without license during open season on own or leased land occupied by them as permanent residence. Unlawful to enter growing grain fields for purpose of hunting without permission of owner.

Bag limits and possession: One deer or 1 antlered moose (but not both), a season; 5 geese a day or in possession; 15 in all of ducks, coot, gallinules, Wilson snipe or jacksnipe, yellowlegs, and rails a day, 45 in possession; 10 quail a day, 20 in possession, 30 a season. Possession permitted during first 5 days of closed season. Under permit or tags deer and moose may be possessed to February 28, migratory birds for 10 days after close of season, and other game birds to January 31.

Sale: Sale of all protected game prohibited, provided, hides of deer and moose legally killed may be sold.

Export: Export of all protected game prohibited, except nonresident licensee may ship home in open season under his license coupons 1 deer, or 1 bull moose, and 25 birds lawfully taken by himself, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week. Deer and moose hides for tanning and heads for mounting may be exported when tagged with license coupons.

Miscellaneous: Unlawful to carry gun in motor vehicle unless taken apart or contained in a case.

MISSISSIPPI.[1]

Open seasons:[1]	*Dates inclusive.*
Deer (male), bear	Nov. 15–Mar. 1.
Rabbit, squirrel	Unprotected.
Quail or partridge	Nov. 1–Mar. 1.
Wild turkey gobblers	Jan. 1–May 1.
Dove	Sept. 16–Dec. 31.
Waterfowl, Wilson snipe or jacksnipe, coot, poule d'eau, gallinule, black-bellied and golden plovers, yellowlegs	Nov. 1–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does; turkey hens (1921).

Hunting licenses: Nonresident, $20 (county license). Issued by sheriff. Landowners and their nonresident relatives and friends may hunt without license during open season on own lands.

Bag limits and possession: One deer a day, 5 a season; 20 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 20 doves, 15 in all of rails, coot, and gallinules, but a mixed bag shall not exceed 20 birds. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited.

MISSOURI.

Open seasons:	*Dates inclusive.*
Deer (buck)	Nov. 1–Dec. 31.
Squirrel	June 1–Dec. 31.
Quail (bob-white partridge)	Nov. 10–Dec. 31.[2]
Wild turkey	Dec. 1–Dec. 31.
Duck, goose, brant, Wilson snipe, coot, gallinules, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.

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[1] *Mississippi:* Local regulations of boards of supervisors may also be in force, but those relating to migratory birds must not be inconsistent with Federal regulations.

[2] *Missouri:* Upon petition of 100 householders to the county court, at any regular or special term thereof, more than 30 days before a general election to be held in such county, the question of a close season on quail for the next two years in such county may be submitted to the qualified voters therein at the election.

Open seasons—Continued.	*Dates inclusive.*
Woodcock	Nov. 10–Nov. 30.
Rail, other than coot and gallinules	Sept. 15–Nov. 30.

No open season: Does, fawns under 1 year of age, ruffed grouse (pheasant), prairie chicken (pinnated grouse), imported pheasants, other introduced game birds, dove.

Hunting and fishing licenses: Nonresident or alien, $10; fish only, $3. Issued by commissioner. Resident, State, $2.50; county, $1, good in county of residence or adjoining county; fish only (State), $1. Issued by county clerk or license collector. Fishing license not required in county of residence nor of women and minors who are citizens. Owners and tenants of agricultural lands and members of family under 21 may hunt without license during open season on own or leased land. Hunting on land of another prohibited without his consent.

Bag limits and possession: One deer, 4 turkeys a season; 1 turkey, 10 quail, 15 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 15 Wilson snipe a day; 15 rails, 15 coots, 15 gallinules, but not more than 25 in all a day or in possession; or 2 turkeys, 15 quail, 25 of any other species of birds in possession. Possession of migratory birds, except doves, permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except game may be exported under resident or nonresident license if carried openly as baggage or express or in owner's possession and accompanied by him, but more than 2 days' limit of migratory birds shall not be exported in any one calendar week. Export (except of quail) for scientific or propagating purposes allowed under permit.

MONTANA.

Open seasons:	*Dates inclusive.*
Deer (see exception)	Oct. 1–Nov. 30.
Exception: Deer in Custer, Dawson, Richland, Rosebud, and Yellowstone Counties (1922); in Roosevelt, Sheridan, and Valley Counties (1921).	
Elk in Carbon, Madison, Park, Stillwater, Sweet Grass, and parts of Beaverhead and Gallatin Counties	Oct. 15–Dec. 24.
In Fergus, Mineral, Wheatland, Ravalli, and parts of Granite, Lewis and Clark, and Powell Counties	Oct. 15–Oct. 24.
In Flathead, Lincoln, Teton, and parts of Granite and Missoula Counties	Oct. 15–Nov. 30.
Pheasant, partridge, prairie chicken, sage hen, fool hen, grouse (see exception)	Sept. 15–Sept. 30.
Exception: In Roosevelt, Sheridan, and Valley Counties	Oct. 1, 1921.
Duck, goose, brant	Sept. 16–Nov. 30.
Black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs, coot, gallinules	Sept. 16–Dec. 31.
Rail other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Sheep, goat (1922); elk (except as above), moose, caribou, antelope, bison or buffalo, quail, introduced pheasant, dove.

Hunting and fishing licenses: Nonresident: General, $50; birds and fish, $15; fish, $3. Alien: General, $50; fish, $5. Resident: General, $1.50. Guide (resident), $10. Shipping (export), 50 cents. Issued by warden or deputy. Elk (special), $25 (2 elk in Park and Gallatin Counties.) Issued by warden.

No license required of female under 18 or of male under 14. Alien not holding a hunting license required to obtain from warden $25 license to possess firearms.

Bag limits and possession: One deer, 1 elk a season except in Gallatin and Park counties where 2 elk may be taken under special $25 license; 5 in all of grouse, partridges, prairie chickens, fool hens, pheasants, and sage hens a day or in possession; 20 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 50 sora, 25 in all of other rails, coot, and gallinules a day. Possession of migratory birds except waterfowl permitted during first 10 days of close season.

Sale: Sale of all protected game prohibited, provided merchant or hotel or restaurant keeper may sell game, except migratory birds, killed outside the State. Under permit mounted specimens or hides or heads of game animals or birds lawfully taken may be sold.

Export: Export of all protected game prohibited; provided game lawfully killed may be exported in open season under hunting license, and shipping permit (fee, 50 cents) from State warden; total shipments under one license shall not exceed season's bag limit, and not more than 2 days' limit of migratory birds shall be exported in any one calendar week; packages to be labeled to show contents.

NEBRASKA.

Open seasons:	*Dates inclusive.*
Squirrel (gray, red, fox, timber)	Oct. 1–Nov. 30.
Prairie chicken, sage chicken, grouse	Sept. 15–Nov. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, yellowlegs, coot, gallinules	Sept. 16–Dec. 31.
Rails, other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Deer, elk, antelope, quail, partridge, pheasant, ptarmigan, introduced game birds, dove, wild turkey, plovers, woodcock.

Hunting and fishing licenses: Nonresident: General, $10; fish, $2. Resident, $1. Issued by commissioner or county clerk. Owner or lessee may hunt and fish without license during open season on lands on which he resides. No license required by male under 18 if accompanied by parent or guardian; male under 18 and female may fish without license. Hunting on land of another without permission or from highways prohibited.

Bag limits and possession: Ten squirrels, 10 prairie chickens or grouse, 25 ducks a day; 8 geese, 8 brant a day, 10 in all in possession; 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules a day; 20 squirrels, 10 prairie chickens or grouse, 10 wild geese or brant, or 50 in all of other game birds in possession. Possession permitted during first 5 days of close season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except nonresident may ship 50 birds out of State in a season under hunting license, but must give common carrier invoice of number and kinds of birds, must have details of shipment marked on license, and must accompany the shipment, but more than 2 days' limit of migratory birds shall not be exported in any one calendar week; package to be labeled to show contents and name and address of owner or consignor.

NEVADA.

Open seasons:[1]	*Dates inclusive.*
Deer	Oct. 15–Nov. 15.
Prairie chicken	Oct. 1–Jan. 15.
Sage hen	July 15–Sept. 1.
Dove	Sept. 1–Dec. 15.[1]
Duck, goose, brant, coot, gallinules, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Rails, other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Elk, antelope, sheep, goat (1930); pheasants (1920); mountain quail, grouse (1922).

Hunting and fishing licenses: Nonresident: Game, $5; fish, $5. Alien: Fish, $15. Resident citizen: Game, $1, fish, $1. Issued by county clerks and wardens. Aliens prohibited from hunting. No license required of boys or girls under 14. Landowners may hunt and fish on own land without license during open season.

Bag limits and possession: One deer a season; 10 sage hens, 15 ducks, 5 geese, 5 brant, 15 snipe a day or in possession; 15 in all of plovers and yellowlegs, 50 sora and 25 in all of other rails, coots, and gallinules, and 25 doves a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited.

NEW HAMPSHIRE.

Open seasons:[2]	*Dates inclusive.*
Deer in Coos County	Oct. 15–Dec. 15.
In Carroll (except town of Moultonborough) and Grafton Counties	Nov. 1–Dec. 15.
In rest of State	Nov. 15–Dec. 15.
Hare, rabbit	Oct. 1–Feb. 29.
Quail, partridge, ruffed grouse, woodcock	Oct. 1–Nov. 30.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinules	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Rails, other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Elk, moose, caribou, dove, pheasant, European partridge; gray squirrel (1924).

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[1] *Nevada:* County commissioners may shorten open seasons on game and with approval of State warden may fix seasons on valley quail and may shorten season on doves.

[2] *New Hampshire:* Governor and council may suspend open season in time of excessive drought.

Hunting and fishing licenses: Nonresident: Game and fish, $15; fish, $1. Resident, Game and fish, $1. Resident soldiers and sailors over 70 years of age may hunt and fish without a license. Fishing licenses not required of children under 16 years of age, nor of women or blind people. Issued by commissioner or his agent in each town, who with few exceptions is the town clerk. Licenses not granted to children under 13 years of age, and only with written consent of parent or guardian to minors under 16 years. Child under 13 may hunt without license when accompanied by licensed parent or guardian. Resident owner of farm lands and minor children may hunt during open season on own land without license. Guide: Nonresident, $20; resident, $1. Issued by commissioner.

Bag limits and possession: Two deer a season; 5 hares, 5 quail a day; 5 ruffed grouse a day, 25 a season; 5 woodcock a day, 25 a season; 20 ducks, 8 geese, 8 brant, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules a day. Deer may be possessed for a reasonable time after close of open season.

Sale: Sale of all migratory birds prohibited. Sale for food purposes prohibited of the dead bodies of birds belonging to a family any species or subspecies of which is native to and protected by the State; provided, deer, hares, and rabbits may be sold during the open season.

Export: Export of all protected game prohibited; provided game (except ruffed grouse) imported from without the United States or raised in private preserves, when tagged and marked to show kind and number, name and address of consignor and consignee, and initial point of billing and destination, may be exported unaccompanied by the owner, but not more than two days' limit of migratory birds shall be exported in any one calendar week. Game for propagation, the head, hide, feet. or fur of game quadrupeds, and the plumage or skin of game birds (except migratory birds) legally taken and possessed may be transported without being marked.[1] Nonresident may take with him out of the State, under his hunting license and permit, one day's limit of game birds when properly marked and tagged and two deer under license tags.

NEW JERSEY.

Open seasons:	*Dates inclusive.*
Deer[2] (male, with horns visible above the hair)	Dec. 16–Dec. 20.
Rabbit, squirrel, quail, ruffed grouse (partridge, prairie chicken, Hungarian partridge, English or ringneck pheasant cocks, wild turkeys	Nov. 10–Dec. 15.
Duck, goose, brant, coot, gallinules	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Wilson snipe or jacksnipe	Oct. 16–Dec. 31.
Woodcock	Oct. 10–Nov. 30.
Rails (marsh hens) other than coot and gallinules	Sept. 1–Nov. 30.
Reedbird	Sept. 1–Oct. 30.[3]

No open season: Does and fawns, English or ringneck pheasant hens (1924); dove.

Hunting and fishing licenses: Nonresident: Game and fish, $10.15; fish, $2.15. Resident male citizen above age of 14: Game and fish, $1.15. When applied for by parent or legal guardian, in discretion of commission, license may be granted to citizen between ages 10 and 14 to hunt when accompanied by adult holder of a general license; fee, $1; issued only by commission. All other licenses issued by county, city, or town clerk, salaried warden, or registrar of licenses.

Alien prohibited from hunting or owning shotgun or rifle unless he is the owner of real property in New Jersey to the value of $2,000 above all incumbrances, in which case he may secure nonresident license.

Bag limits and possession: One deer a season, 10 rabbits, 10 quail, 3 ruffed grouse, 3 English or ringneck pheasant cocks, 3 Hungarian partridges, 6 woodcock, 20 ducks, 8 each of geese and brant, a day; 25 snipe, 15 in all of plovers and yellowlegs, 50 sora and 25 in all of other rails (marsh hens), coot, and gallinules a day. Possession of migratory birds permitted during the first 10 days of close season.

Sale: The sale of deer, squirrel, reedbirds, and all game birds is prohibited; rabbits may be sold during open season and 15 days thereafter; certain imported game, also mallard, wood, and black ducks (when raised in captivity under Federal permits), deer, and pheasants coming from another State may be sold if legally tagged by State authorities.

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[1] *New Hampshire:* See sec. 243, Lacey Act, p. 63.

[2] *New Jersey:* Wild deer may be taken only with shotgun not smaller than 12 gauge, which may not be loaded with a bullet or other missile larger than buckshot. Killing of a deer must be reported to commissioners or county warden within 48 hours.

[3] See order of the Secretary of Agriculture, p. 77.

Export: Export of hare, rabbit, squirrel, woodcock, waterfowl, and all protected upland game birds is prohibited, except nonresident licensee may carry openly from the State 10 rabbits, 50 rail, 50 reedbirds, and 15 in all of other game birds a day, but not more than two days' limit of migratory birds shall be exported in any one calendar week.

Resident may remove from State reedbirds (no limit), 30 in all of plovers and yellowlegs, 50 Wilson snipe, and 100 sora and 50 other rails or marsh hens, coot, and gallinules a week.

Miscellaneous: Unlawful to use shotgun or rifle holding more than 2 cartridges or that may be fired more than twice without reloading.

NEW MEXICO.

Open seasons:	*Dates inclusive.*
Deer (with horns at least 6 inches in length), squirrel (tassel-eared gray), wild turkey	Oct. 20–Nov. 5.
Quail (except bob-white)	Nov. 1–Dec. 31.
Turtle dove and white-winged dove	Sept. 1–Dec. 15.
Duck, goose, brant, Wilson snipe, coot, gallinules	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Rails other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Does, Sonoran deer, elk, sheep, goat, antelope, buffalo, bob-white quail, pheasant, ptarmigan, prairie chicken, sage hen, grouse.

Hunting and fishing licenses: Nonresident: Big game, bird, and fish, $35.25; big game and bird, $30.25; big game, $25.25; bird, $10.25; fish, $5. Resident: Big game, bird and fish, $2.50; big game and bird, $2.25; big game, $1.50; bird, $1.25; fish, $1; guide, $5.25; duplicate, $1. Issued by county clerks and deputies designated by State warden.

Bag limits and possession: One deer a season, 3 wild turkeys, 20 quail, 25 doves a day or in possession, 25 ducks, 8 geese, 8 brant, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora and 25 in all of other rails, coots, and gallinules. Possession permitted during open season and first 5 days of close season. Under permit, game, except migratory birds, may be held in storage for first 90 days of close season; migratory birds may be so held for a period of 10 days.

Sale: Sale of all protected game taken in the State prohibited; provided, game (except migratory birds) imported into State by hotel, restaurant, café, boarding-house keeper, or dealer may be sold under a permit good for not more than 30 days.

Export: Export of all game taken in the State prohibited, except under permit, fee $1.25 (1 deer and 3 turkeys); and $1.25 for bag limit of other birds and fish; holder of hunting license, under permit from warden, may export game or birds for scientific or propagating purposes.

NEW YORK.

Open seasons: [1]	*Dates inclusive.*
Deer (except fawns) in Adirondack region [2]	Oct. 1–Nov. 15.
Deer (with horns not less than 3 inches long), in Ulster County and towns of Neversink, Cochecton, Tusten, Highland, Lumberland, Forestburg, Bethel, and all of towns of Mamakating and Thompson south of Newburgh and Cochecton turnpike in Sullivan County, and Deer Park, in Orange County	Nov. 1–Nov. 15.
On own land in Columbia, Dutchess, and Rensselaer Counties with shotguns only	Oct. 1–Nov. 15.
Varying hare, rabbit [3]	Oct. 1–Jan. 31.
Squirrel, black, gray, or fox (no open season in corporate limits of city or village)	Oct. 1–Nov. 15.

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[1] *New York:* When date of open or close season falls on Sunday, season opens, except on migratory birds, or closes on the preceding Saturday.

[2] The Adirondack region comprises the counties of Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Jefferson, Lewis, Oneida, Oswego, Saratoga, St. Lawrence, Warren, and Washington.

[3] Commission may shorten open seasons on game. Open season on upland game fixed or closed by order of commission as follows: *Cottontail rabbit* in Richmond County, Oct. 1–Nov. 14 and Jan. 1–31.

Open seasons—Continued.

	Dates inclusive.
Grouse, partridge[1]	Oct. 1–Oct. 31.
Pheasant, male only[1] (four days only)	Oct. 23 and 30. Nov. 1 and 8.
Waterfowl, Wilson snipe or jacksnipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 30.
Rails, other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Elk, moose, caribou, antelope, fawns, Hungarian or European gray-legged partridge, dove, and quail (1920).

Hunting licenses: [2] Nonresident or alien, $10.50; resident, $1.10. Issued by county, city, and town clerks. Owner, members of immediate family, and tenants actually occupying cultivated farm land may hunt thereon without license during open season. Licensee required to wear button.

Bag limits: One deer, 24 woodcock, 20 grouse, 3 male introduced pheasants a season; 6 varying hares or rabbits, 5 squirrels, 6 woodcock, 4 grouse, 25 ducks, 8 geese, 8 brant, 25 in all of rails, coots, mud hens and gallinules, 15 in all of plovers and yellowlegs, 25 Wilson snipe or jacksnipe a day.

Possession: Deer, grouse, and pheasant during open season and 5 days thereafter; migratory game birds during open season and 10 days thereafter. Deer properly tagged may be possessed under $1 permit to February 1.

Sale: Sale of all game birds prohibited; provided, varying hares and rabbits legally taken in State during open season (from without State at any time), and unplucked carcasses of pheasants, Scotch grouse, European gray-legged partridge, European black game, red-legged partridge, and Egyptian quail, and carcasses of European red deer, fallow deer, roebuck, and reindeer imported from without the United States may be sold under license at any time when duly tagged.

Licensed breeders in States having laws similar to the game-breeding law of New York may import for sale, under $5 license and cost of inspection, domesticated American elk, white-tailed deer, European red deer, fallow deer, roebuck, pheasants, and mallard and black ducks, when duly tagged.

Head, hide, and feet of quadrupeds legally taken and possessed may be sold at any time.

Export: Export of game and birds prohibited, except any person may export 1 deer and one day's bag limit of other game in one day during open season by means other than common carrier or parcel post. The taker may export in one day by common carrier, except parcel post, one day's limit when accompanied by permit which shall show contents of package. Head, hide, and feet of animals and plumage or skin of game birds legally taken may be exported at any time.

Miscellaneous: Hunting prohibited on lands supplying any municipality with water or on public highways, except public highways within forest preserve counties.

NEW YORK—Long Island.

Open seasons:

	Dates inclusive.
Varying hare, rabbit, squirrel (black, gray, fox), quail, pheasants (males only)	Nov. 1–Dec. 31.
Ruffed grouse	Nov. 1–Nov. 30.
Waterfowl, Wilson snipe or jacksnipe, coot, mudhen, gallinules	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 30.
Rails, other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Deer and dove.

Bag limits and possession: Forty quail, 15 ruffed grouse, 30 male pheasants a season; 6 quail, 2 ruffed grouse, 4 male pheasants a day. For other bag limits see New York.

Hunting licenses, sale, export, miscellaneous: (See New York.)

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[1] *New York:* Commission may shorten open seasons on game. Open season on upland game fixed or closed by order of commission as follows: *Cottontail rabbit* in Richmond County, Oct. 1–Nov. 14 and Jan. 1–31.

[2] Nonresident fishing license fee, $2.50. Issued by county, city, and town clerks. Not required of person under 16 years of age or in international boundary waters if residents require no license in that part of those waters not within jurisdiction of State.

NORTH CAROLINA.[1]

Open seasons:[1]	*Dates inclusive.*
Dove	Sept. 16–Dec. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinules	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Woodcock	Nov. 1–Dec. 31.
Rails other than coot and gallinules	Sept. 1–Nov. 30.
Reedbird (ricebird)	Aug. 16–Nov. 15.[2]

Hunting licenses.[1]

Bag limits and possession: Twenty-five doves, 25 ducks, 8 geese, 8 brant, 6 woodcock, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of reedbirds (ricebirds) and all migratory birds prohibited.

Export: The export is prohibited of quail, partridge, pheasant, grouse, wild turkey, snipe, shore or beach birds, woodcock, taken in State.

Exceptions: Nonresident may take out of State under his hunting license 50 quail (partridges), 12 grouse, 2 turkeys, and 50 in all of Wilson snipe, plovers, and yellowlegs in a season, but not more than two days' limit of migratory birds shall be exported in any one calendar week. Export permitted under permit of Audubon Society of ruffed grouse, wild turkey, woodcock, snipe, and other shorebirds for propagation.

NORTH DAKOTA.

Open seasons:	*Dates inclusive.*
Prairie chicken (pinnated grouse), sharp-tailed (white-breasted) grouse, black-bellied and golden plovers, yellowlegs, Wilson snipe	Sept. 16–Oct. 16.
Ruffed grouse in Bottineau, Cavalier, Pembina, and Roulette Counties only	Oct. 1–Oct. 16.
Duck, goose, brant	Sept. 16–Dec. 1.
Coot, gallinules	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Oct. 16.
Rails other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Deer (1920); elk, moose, antelope, quail, ruffed grouse (except as above), English and Chinese ringneck pheasants, Hungarian partridge, dove, woodcock.

Hunting licenses: Nonresident, $25; resident, $1. Issued by commissioners, deputy, or county auditor. Aliens not permitted to hunt. Person or member of family permanently residing with him may hunt without license during open season on own lands or lands cultivated by him. Resident license may be issued to settler. No person permitted to enter cultivated or posted lands without consent of owner.

Bag limits and possession: Five prairie chickens, sharp-tailed grouse, plovers, each or all combined a day, 10 each or all in possession at one time, 15 in all of plovers and yellowlegs, but not more than 5 plovers a day; 5 ruffed grouse a day, 15 in possession; 15 snipe, woodcock, rails, ducks, geese, each or all combined a day, but not more than 8 geese, 8 brant, or 6 woodcock; 30 in possession; 25 in all of rails, coots, and gallinules a day. Resident licensee under permit may retain not to exceed 20 pinnated or sharp-tailed grouse, 30 waterfowl, but not more than 50 birds in all during first 5 days of close season.

Sale: Sale of all protected game prohibited, except hides, heads, and trophies of big game lawfully taken may be sold at any time.

Export: Export of all protected game prohibited, except nonresident licensee may carry with him from State under license tag prairie chickens and sharp-tailed grouse not exceeding 20 in all, and ducks, geese, and brant not exceeding 30 in all, or a total of 50 of all birds combined, if open to view and labeled with his name and address and number of his license. Not more than 2 days' limit of migratory birds shall be exported in any one calendar week. Board may grant permits for the export of live game.

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[1] *North Carolina:* Only the Federal seasons and other restrictions on migratory birds are given. County seasons and provisions relating to licenses, bag limits, sale, and export are too numerous to be included. Full information regarding county laws may be had on application to the secretary, Audubon Society, Raleigh, N. C. The county laws should be consulted, as in some instances they prohibit the hunting of migratory game birds during part of the periods mentioned in the table. Wood duck, swans, robins, larks, and certain other migratory birds must not be killed at any time. (See Migratory Bird Regulations, pp. 71–77.)

[2] See order of the Secretary of Agriculture, p. 77.

OHIO.

Open seasons:	*Dates inclusive.*
Hare, rabbit	Nov. 15–Jan. 1.[1]
Squirrel	Aug. 20–Sept. 20.
Ruffed grouse, cock pheasant (introduced), Hungarian partridge	Nov. 15–Nov. 25.
Duck, goose, brant, Wilson snipe, black-bellied and golden plovers, yellowlegs, coot, gallinules	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Nov. 30.
Rails, other than coot and gallinules	Nov. 1–Nov. 30.

No open season: Deer, quail, dove.

Hunting and fishing licenses: Nonresident citizen: General, $15.25; fish, $2. Resident citizen, $1.25. Issued by county and township clerks. Person under 16 when hunting must be accompanied by adult. Owners, tenants, or their children may hunt without license during open season on own or leased lands. Written permission required on land of another.

Bag limits and possession: Five squirrels and 10 rabbits a day or in possession; 3 ruffed grouse, 3 cock pheasants, and 6 Hungarian partridge, 15 in all of plovers and yellowlegs, 15 Wilson snipe, 6 woodcock, 8 geese, 25 ducks; 35 sora and 25 in all of other rails, coots, and gallinules a day.

Sale: Sale prohibited of all protected game (except hare or rabbit during open season).

Export: Export prohibited of all protected game (except rabbit) taken in State, provided, a nonresident may take with him from State under his hunting license 25 pieces of game, but not more than 2 days' limit of migratory birds shall be exported by one person in any one calendar week. Packages containing game or fur-bearing animals or parts thereof must be marked to show contents, initial point of billing, and names and addresses of consignor and consignee.

OKLAHOMA.

Open seasons:[2]	*Dates inclusive.*
Quail	Dec. 1–Dec. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinules	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs, dove	Sept. 1–Dec. 15.
Woodcock	Nov. 1–Dec. 31.
Rails other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Deer (1922), antelope, prairie chicken, imported pheasant, wild turkey.

Hunting licenses: Nonresident, $15; alien, $25; resident citizen, $1.25. Issued by warden, deputy, or county clerk. A person may hunt without license during open season on own or leased premises actually occupied by him. Application of person under 14 must be approved in writing by parent or guardian. Unlawful to shoot on or across highway or railroad right of way. Unlawful to hunt on lands of another without owner's permission.

Bag limits: Fifteen quail, plover, snipe, or ducks a day, 100 a season; 15 yellowlegs, but not more than 15 in all of plovers and yellowlegs a day; 8 geese, 8 brant a day, but not more than 10 in all a day; 50 sora and 25 in all of other rails, coots, and gallinules and 6 woodcock a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale prohibited of all protected game, except the heads, hides, and horns of big game lawfully killed may be sold.

Export: Export prohibited of all protected game, except nonresident licensee may carry to his home two days' bag limit of game birds if license permit is attached.

OREGON.[3]

Open seasons:

District No. 1,[4] west of Cascades:	*Dates inclusive.*
Deer (male, with horns)	Sept. 1–Oct. 31.
Silver-gray squirrel, dove	Sept. 1–Oct. 31.
Quail in Coos, Curry, Jackson, and Josephine Counties only	Oct. 1–Oct. 31.

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[1] *Ohio:* Landowners, tenants, and employees may take hares or rabbits, when doing substantial damage to crops, trees, or shrubbery, at any time except on Sunday.

[2] *Oklahoma:* Bear in Blaine, Caddo, Comanche, Kiowa, and Major Counties, no open season; in rest of State, unprotected.

[3] *Oregon:* Governor may suspend open season in time of drought.

[4] District No. 1, west of Cascades, includes Benton, Clackamas, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties. District No. 2 east of Cascades, includes all other counties in the State.

Open seasons—Continued.	*Dates inclusive.*
Grouse, male Chinese pheasant (see exceptions)	Oct. 1–Oct. 31.
Exceptions: Grouse and male Chinese pheasant in Jackson County	Oct. 1–Oct. 10.
Chinese pheasants in Coos, Curry, and Josephine Counties	No open season.
Sooty or blue grouse in Douglas County	Sept. 1–Sept. 30.
Duck, goose, brant, Wilson snipe, coot, black-bellied and golden plovers, yellowlegs (see exception)	Oct. 16–Jan. 15.
Exception: In Clatsop, Columbia, Multnomah, and Tillamook Counties	Oct. 1–Dec. 31.
Rails, other than coot (see exception)	Oct. 16–Nov. 30.
Exception: In Clatsop, Columbia, Multnomah, and Tillamook Counties	Sept. 16–Nov. 30.
District No. 2,[1] east of Cascades:	
Deer (male, with horns) (see exception)	Sept. 1–Oct. 31.
Exception: In Union and Wallowa Counties	Sept. 10–Nov. 10.
Quail in Klamath County only	Oct. 1–Oct. 10.
Ruffed grouse, native pheasant, blue or sooty grouse (see exception)	Aug. 15–Oct. 31.
Exception: In Union and Wallowa Counties	Aug. 1–Nov. 10.
Prairie chicken in Sherman and Wasco Counties only	Oct. 1–Oct. 15.
Sage hen	July 15–Aug. 31.
Chinese pheasants in Baker, Grant, Malheur, Umatilla, and Union Counties	Oct. 5–Oct. 12.
In Hood River and Wasco Counties	Oct. 27–Nov. 3.
In remainder of district	No open season.
Dove	Sept. 1–Oct. 31.
Duck, goose,[2] Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs, coot, gallinules	Oct. 1–Dec. 31.
Rails, other than coot	Oct. 1–Nov. 30.

No open season: Doe and spotted fawn, moose, elk, antelope, sheep, goat, Hungarian partridge, bob-white, prairie chicken, Franklin grouse, foolhen, wild turkey, silver-gray squirrel, quail, and introduced pheasants (except as above).

Hunting and fishing licenses: Nonresident: Game, $10; alien, gun license, $25 (in addition to hunting and angling license); issued by commissioners. Resident, game and fish, $3; game, $1.50. Angling, resident or nonresident,[3] $1.50 (not required of female); issued by county clerks and duly appointed agents throughout the State. Licenses not issued to persons under 14 years of age, who may hunt with gun on own premises or those of parent, relatives, or guardian only. Unlawful to hunt on inclosed or occupied land of another without permission of owner. Unlawful to shoot from highways or railroad rights of way. Licenses, good for life, issued free of charge by county clerks to pioneers of State who arrived prior to 1860, and veterans of Indian and Civil Wars upon proof of service.

Bag limits and possession: Two deer a season; 5 silver-gray squirrels and 10 quail in 7 consecutive days; 5 in all of sage hens and prairie chickens a day, 10 in 7 consecutive days; 5 in all of ruffed grouse, pheasants, and sooty or blue grouse a day, 10 in 7 consecutive days; 5 Chinese pheasants a day, 10 in 7 consecutive days, but in district 1 a bag of 10 shall not include more than 3 hens and in district 2 more than 2 hens; 10 doves a day, 20 in 7 consecutive days; 25 ducks, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 25 in all of rails, coots, and gallinules a day but not more than 25 in all in one day nor more than 30 in all in 7 consecutive days; 8 geese a day, 30 in 7 consecutive days. Migratory game birds properly tagged may be possessed during first 10 days of close season; other game, when properly tagged, during close season.

Sale: Sale of all protected game prohibited. Game birds (except migratory birds) and animals imported from without the United States, when duly tagged, may be sold. Tag fee, 5 cents each. Commissioners may make regulations permitting the sale of game, except migratory birds.

Export: Export of all protected game prohibited.

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[1] *Oregon:* District No. 1, west of Cascades, includes Benton, Clackamas, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties. District No. 2 east of Cascades, includes all other counties in the State.

[2] Unlawful to kill geese at any time on islands or sand bars in the Columbia east of the Cascades or on Deschutes and John Day Rivers south to junction with White River and Thirtymile Creek, respectively.

PENNSYLVANIA.

Open seasons: [1]	*Dates inclusive.*
Deer—male with horns 2 inches above the hair	Dec. 1–Dec. 15.
Bear	Oct. 15–Dec. 15.
Hare, rabbit	Nov. 1–Dec. 15.
Squirrels, quail, ruffed grouse, ringneck pheasant, Hungarian partridge	Oct. 20–Nov. 30.
Wild turkey	Nov. 15–Nov. 30.
Duck, goose, brant	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs, coot (mudhen), gallinules, Wilson snipe or jacksnipe	Sept. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 30.
Rail	Sept. 1–Nov. 30.
Reedbird	Sept. 1–Oct. 30.[2]
Blackbird	Aug. 1–Nov. 30.

No open season: Elk (1921), doe, fawn, dove, loon, grebe.

Hunting licenses: Nonresident, $10. Issued by commission or county treasurer. Resident, $1 from county treasurer, $1.15 from justice of the peace. Licenses not issued to minor under 14 years of age, and minor between 14 and 16 must furnish written consent of parent or guardian. Licensee required to wear tag.

Resident citizen and members of family residing upon and cultivating land in State as either owner or lessee may hunt on such land and, with consent of owner, on adjoining land without a license.

Aliens not permitted to hunt.

Bag limits and possession: One deer (6 to party camping or hunting together), 1 bear (3 to party camping or hunting together), 40 rabbits, 15 hares, 20 squirrels, 1 turkey, 25 quail (Virginia partridge), 24 ruffed grouse, 10 ringneck pheasants, 10 Hungarian quail, 20 woodcock a season. Ten rabbits, 3 hares, 6 squirrels, 8 quail (Virginia partridge), 4 ruffed grouse, 4 ringneck pheasants, 4 Hungarian quail, 6 woodcock, 25 ducks, 8 geese, 8 brant, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 30 days thereof.

Sale: Sale prohibited of wild deer, elk, squirrel, rabbit or hare, wild ringneck pheasant, and Hungarian partridge taken in the State; and of quail, ruffed grouse (pheasant), wild turkey, reedbirds, and all other migratory birds (wherever taken); provided, bear, blackbirds, Belgian and German hares may be sold at any time.

Export: The export is prohibited of all protected game, provided a nonresident licensee may take out with him on the same conveyance one day's limit of game. Small game to be carried upon the person in hunting coat or game bag, or as hand baggage, without cover. Packages containing large game to be plainly marked. Shipment by parcel post prohibited.

Miscellaneous: Use of automatic guns prohibited.

RHODE ISLAND.

Open seasons:	*Dates inclusive.*
Gray squirrel, hare, rabbit, quail or bobwhite, ruffed grouse or partridge, pheasant	Nov. 1–Dec. 31.
Duck, goose, brant, coot, gallinules	Oct. 1–Jan. 15.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Wilson snipe	Oct. 1–Nov. 30.
Woodcock	Nov. 1–Nov. 30.
Rails (other than coot and gallinules)	Sept. 1–Nov. 30.

No open season: Deer,[3] dove, Hungarian partridge (1920).

Hunting licenses: Nonresident, $10.15; alien, $15.15; resident, $1.15. Issued by city and town clerks.

Not required of resident or his immediate family to hunt on own or leased agricultural lands on which actually domiciled; nonresident owning real estate valued at not less than $500, and nonresident member of club incorporated for hunting or fishing purposes prior to Jan. 1, 1900, which owns real estate assessed for taxation at value of not less than $1,000, may procure license at a fee of $1.15; licenses not issued to minors under 15 years of age. Consent of owner required for hunting on land of another from Oct. 15–Dec. 15.

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[1] *Pennsylvania:* Seasons may be closed on petition to commission.

[2] See order of the Secretary of Agriculture, p. 77.

[3] *Rhode Island:* Deer injuring crops may be killed at any time by the owner or occupant of the premises under written permit from secretary of State.

Bag limits and possession: Fifteen ducks, 8 geese, 8 brant, 6 woodcock, 15 in all of plovers and yellowlegs, 15 Wilson snipe, 15 in all of rails, coots, and gallinules a day, but not more than 15 game birds of all kinds in possession at one time. Possession of waterfowl, coots, gallinules, and woodcock permitted during first 10 days of close season.

Sale: Sale of all protected game birds prohibited.

Export: Export prohibited of all game, provided a nonresident licensee may take out under his license 10 wild fowl or birds in one calendar year, if carried open to view.

SOUTH CAROLINA.

Open seasons:	*Dates inclusive.*
Deer	Sept. 1–Dec. 31.
Bear, rabbit, squirrel, blackbirds	Oct. 1–Mar. 15.
Quail (partridge)	Nov. 15–Feb. 15.
Wild turkey	Nov. 15–Apr. 1.
Dove	Oct. 16–Jan. 31.
Duck, goose, brant, coot, gallinules, Wilson snipe	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Rails, other than coot and gallinules	Sept. 1–Nov. 30.
Woodcock	Nov. 1–Dec. 31.
Reedbirds	Aug. 16–Nov. 15.[1]

No open season: Ruffed grouse (pheasant) (1924).

Hunting and fishing licenses: Nonresident: Game, $15.25; fish, $3.25. Issued by county clerk. Resident: Game, State, $3.10; county of residence, $1.10. Issued by county clerk or game warden.

No license required of resident owners, tenants, their children, or, under written permission, their employees, to hunt during open season on own lands.

Unlawful to hunt on land of another without consent of owner.

Bag limits: Five deer, 20 wild turkeys a season; 15 squirrels, 15 quail (partridge), 25 doves, 2 turkeys, 25 ducks, 8 geese, 8 brant, 6 woodcock, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale prohibited of deer, quail (partridge), dove, turkey, reedbird, and all other migratory birds.

Export: Export prohibited of all protected game taken in State; provided, a nonresident licensee may export 2 deer, 50 quail, 4 turkeys, 50 in all of plover, yellowlegs, and snipe, 50 waterfowl if not for sale and packages are marked to show contents, but not more than two days' limit of migratory birds shall be exported in any one calendar week.

SOUTH DAKOTA.

Open seasons:	*Dates inclusive.*
Deer	Nov. 1–Nov. 30
Partridge, grouse, prairie chicken, black-bellied and golden plovers, yellowlegs	Sept. 16–Oct. 15.
Duck, goose, brant, coot, gallinules, Wilson snipe	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Nov. 30.
Rails, other than coot and gallinules	Sept. 16–Nov. 30.

No open season: Elk, antelope, mountain sheep, quail, dove, pheasant, upland plover.

Hunting licenses: Nonresident: Big game, $25; small game, $15; issued by game warden or county treasurer. Resident: Big game, $5; small game, $1; issued by county treasurer. Hunting game birds during open season on own land permitted without license. Unlawful to hunt on cultivated land of another without permission of owner.

Bag limits and possession: One deer a year; 25 ducks, geese, brant, coot, gallinules, sora and other rails in the aggregate of all kinds, but not more than 8 geese or 8 brant, and 5 of each other species of game birds a day; 50 in all of ducks, geese, or brant, or other aquatic fowl and snipe, and 15 in all of prairie chickens, partridge, grouse, and plover in possession. Possession permitted during open season and five days thereafter.

Sale: Sale of all protected game prohibited; provided, skins, heads, and antlers of deer lawfully killed may be sold.

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[1] *South Carolina:* See order of the Secretary of Agriculture, p. 77.

Export: Export of all protected game prohibited; provided, a nonresident may export 1 deer lawfully killed under permit of State game warden and not more than 10 birds under each of the five coupons attached to his nonresident license; but not more than 50 ducks, 16 geese, 16 brant, 12 woodcock, 50 snipe, 30 in all of plovers and yellowlegs, and 50 in all of rails, coots, and gallinules shall be exported by one person in any one calendar week, and if exported by common carrier, tags attached to hunting license must be affixed to each shipment.

TENNESSEE.

Open seasons:	*Dates inclusive.*
Deer (see exception)	Oct. 15, 1919.
Exception: In Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren Counties	Nov. 1–Dec. 10.
Squirrel (see exceptions)	June 2–Dec. 31.
Exceptions: In Bledsoe, Cannon, Cumberland, Franklin, Grundy, Lincoln, Loudon, Marion, Marshall, Sequatchie, Sumner, and Van Buren Counties unprotected; in Dickson, June 1–Nov. 1; in Dyer, June 1–July 1 and Oct. 1–Jan. 1; in Fayette, Rutherford, June 1–Jan. 1; in Giles, Oct. 15–July 1; in Smith and Wilson, May 1–Mar. 1; in Warren, Nov. 1–Mar. 1.	
Rabbit	Unprotected.
Quail or partridge, wild turkey (additional season for gobblers, Apr. 2–24 (see exceptions)	Nov. 16–Dec. 31.
Exceptions: Quail, in Bedford and Moore Counties, Dec. 1–Jan. 1; in Benton, Dec. 1–Jan. 31; in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren, Nov. 1–Jan. 1; in Bradley, Campbell, Franklin, Giles, Henry, Hickman, and Knox, Dec. 1–Feb. 1; in Carroll, Dec. 1–Jan. 31; in Cannon and White, Nov. 15–Feb. 15; in Crockett, Rutherford, and Sumner, Nov. 15–Jan. 1; in Dickson, Lawrence, and Obion, Nov. 15–Jan. 15; in Dekalb, Hawkins, and Meigs, Nov. 15–Feb. 1; in Fayette, Nov. 22–Mar. 5; in Hardeman, Dec. 15–Mar. 1; in Henderson, McNairy, and Weakley, Dec. 15–Feb. 15; in Monroe, Dec. 1–Jan. 15; in Lincoln, Dec. 1–Feb. 15; in Sullivan, Nov. 20–Feb. 15; in Washington, Nov. 20–Jan. 1; in Warren, Dec. 1–Mar. 1. Season closed in Grainger until 1921; in Union until 1924; Claiborne, no open season. *Wild turkey,* in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren Counties, Nov. 1–Jan. 1, and also on gobblers only, Apr. 1–May 1; in Lincoln, Nov. 1–Mar. 1, and also on gobblers only, Apr. 1–Apr. 25; in Cannon and Sullivan, unprotected.	
Dove (see exceptions)	Sept. 1–Dec. 15.
Exceptions: In Fayette, Sept. 1–Nov. 1; in Obion, Sept. 1–Sept. 15; in Sullivan, Nov. 20–Dec. 15; in Claiborne, no open season.	
Duck, goose, brant, coot, mudhen, gallinule, Wilson snipe or jacksnipe	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Rail	Sept. 1–Nov. 30.

No open season: Deer (1919); grouse, ringneck, and Mongolian pheasant, and woodcock.

Hunting licenses: Nonresident, $10 (may hunt on own land without license). Resident: State, $2; county, $1 (county licensee may obtain State license for $1). Issued by county clerks. County license not required of residents in Cannon, Hardin, Houston, and Jackson Counties or of residents to hunt squirrels in Dyer, Lincoln, Smith, Wayne, and Wilson Counties.

Owners and tenants may hunt without license on land on which they reside. Unlawful to hunt on tillable or inclosed lands of another without written permission.

Reelfoot Lake: Special license, fee $2, in addition to State license, required of residents to hunt thereon. Resident, fish, $1. Nonresident, fish, $2. Guide or pusher, $1.

Bag limits and possession: Twenty game birds and animals a day but not more than 8 geese, 8 brant, 15 in all of plovers and yellowlegs a day; in Lauderdale County, 6 squirrels, 12 quail, and 2 turkeys a day or in possession.

Sale: Sale prohibited of migratory birds and of all other protected birds killed in State.

Export: Export of all protected game prohibited, provided nonresident licensee may take out of State, if carried openly, game birds legally killed by him (except 25 birds only may be exported from Reelfoot Lake), but not more than 50 ducks, 16 geese, 16 brant, 10 Wilson snipe, 30 in all of plovers and yellowlegs, 50 in all of rails, coots, and gallinules, and 50 doves shall be exported by one person in any one calendar week.

TEXAS.

Open seasons:	*Dates inclusive.*
Deer	Nov. 1–Dec. 31.
Quail or partridge, chacalaca or Mexican pheasant	Dec. 1–Jan. 31.
Wild-turkey gobblers	Mar. 1–Apr. 30.
Doves	Sept. 1–Dec. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinules	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Oct. 16–Dec. 15.
Rails, other than coot and gallinules	Oct. 16–Nov. 30.

No open season: Antelope, sheep (1924); turkey hens, robins; prairie chicken, pinnated grouse, pheasant (except chacalaca), woodcock (1924).

Hunting licenses: Nonresident or alien, $15; issued by game, fish, and oyster commissioner, deputies, and county clerks. Resident, $2, not required in county of residence; issued by commissioner, deputies, and county clerks.

Bag limits and possession: Three deer, 3 turkey gobblers a season; 15 in all of quail and chacalaca; 15 doves; 25 in all of waterfowl and shorebirds, but not more than 8 geese, 8 brant, or 15 plovers and yellowlegs a day; 50 sora and 25 in all of other rails, coots, and gallinules. Possession of all game permitted during open season and 10 days thereafter.

Sale: Sale prohibited of all protected game.

Export: Export prohibited of all game, except nonresident licensee may ship game to his home for own use under affidavit that it was lawfully killed and will not be bartered or sold; provided, that not more than two days' limit of migratory birds may be exported in any one calendar week. Game may be shipped to taxidermist for mounting under affidavit that shipper killed the specimen and that it is not being preserved for sale.

UTAH.

Open seasons:[1]	*Dates inclusive.*
Deer (buck, with horns)[2]	Nov. 1–Nov. 10.
Dove	Sept. 1–Sept. 30.
Duck, goose, coot, gallinule (see exceptions)	Oct. 1–Dec. 31.
Exceptions: Waterfowl, in Kane, San Juan, and Washington Counties	Oct. 1–Jan. 15.
Duck in Fish Lake Game Preserve	Oct. 1–Nov. 30.
Rail other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Does, fawns, elk, antelope, sheep, quail, partridge, prairie chicken, blue grouse, sage hens, pheasants, shorebirds, Wilson snipe.

Hunting and fishing licenses: Any male citizen, for game and fish, 12 to 16 years, $1; 16 and over, $2. Females over 18, $1. Aliens prohibited from hunting or fishing in State. Residents under 12 not required to secure license. Issued by State fish and game commissioner or deputy, country clerk, or deputy or authorized agent.

Bag limits: One deer a season (resident citizen only); 25 doves, 25 in all of ducks and geese, but not more than 8 geese a day; 50 sora and 25 in all of other rails, coot, and gallinules a day.

Sale: Sale of all protected game prohibited.

Export: Export of all game prohibited; provided, nonresident licensee may ship out 25 ducks in any one calendar week after they have been examined by the commissioner or one of his deputies and a permit issued therefor.

VERMONT.

Open seasons:	*Dates inclusive.*
Deer (other than spotted fawn)[3]	Dec. 1–Dec. 6.
Hare, rabbit	Sept. 15–Feb. 29.

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[1] *Utah:* Commissioner may open and fix seasons and bag limits on quail, pheasants, grouse, sage hens, and doves.

[2] Nonresident not permitted to kill deer.

[3] *Vermont:* Landowner, member of his family, or authorized employee may kill deer doing damage to his fruit trees or crops; but the person under whose direction a deer is so killed must, within 12 hours, report the matter in a signed statement to the nearest fish and game warden. Deer may also be killed at any time in orchard zones established by the commissioner, but such killing must forthwith be reported to the owner of the orchard and the county warden.

Open seasons—Continued.	*Dates inclusive.*
Gray squirrel, quail	Sept. 15–Nov. 30.
Duck, goose, brant, coot, gallinules	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs, English or Wilson snipe (jacksnipe)	Sept. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 30.

No open season: Elk (1923), moose, caribou, fawns, dove, rail; pheasants, European partridge (1932); ruffed grouse and partridge (1921).

Hunting and fishing licenses: Nonresident: Game and fish, $10.50; owner of real estate in State to value of $1,000, $1; fish, $2. Resident: Game and fish, $1; game, 60 cents; fish, 60 cents. Issued by town clerks.

Hunting licenses not issued to persons under 16 without written consent of parent or guardian. Owners of farm lands and their resident minor children or tenants may hunt without a license during open season on own lands. Fishing licenses not required of persons under 16 or of women.

Bag limits and possession: One deer, 25 woodcock a season; 5 hares or rabbits, 5 squirrels, 4 quail, 20 ducks, 8 geese, 8 brant, 10 plover, and 10 yellowlegs, but not more than 15 in all, 4 woodcock, 10 Wilson snipe, 25 in all of coots and gallinules a day.

Possession of waterfowl, coots, and gallinules permitted during first 10 days of close season.

Sale: Sale of all protected game birds prohibited; deer may be sold during open season and for a "reasonable time thereafter," and hares and rabbits during the open season. Head and hide of deer legally taken may be sold.

Export: Export prohibited of all protected game, except hares and rabbits; provided, a nonresident licensee may export one deer and one day's bag limit of game birds under permit, but must accompany shipment; resident may export (if not for sale) one day's bag limit of game birds under special permit from commissioner.

VIRGINIA.

Open seasons:[1]		*Dates inclusive.*
Deer (see exceptions)		Sept. 1–Dec. 1.
Exceptions: In Chesterfield, Mecklenburg, Prince George, and Surry Counties	Oct. 1–Jan. 1.	
In Brunswick and Greenesville	Oct. 1–Feb. 1.	
In Amelia and Nottoway	Nov. 1–Dec. 31.	
In Bath and Highland (1921); deer and elk in Shenandoah (1920); deer (1921) and elk (1923) in Alleghany, Bland, Botetourt, Craig, Franklin, Giles, Montgomery, Patrick, Pulaski, Rockbridge, Rockingham, Russell, and Wythe Counties.		
Rabbit[2]		Nov. 1–Feb. 1.
Squirrel[3] in Amelia, Brunswick, Caroline, Charles City, Greenesville, James City, New Kent, Nottoway, Spotsylvania, Stafford, Warwick, and York Counties		Nov. 1–Feb. 1.
In Loudoun	June 1–Oct. 31.	
In Isle of Wight and Southampton	Sept. 1–Jan. 15.	
In Rappahannock	Nov. 1–Jan. 31.	
In Shenandoah	Aug. 15–Oct. 1.	
In Warren	Nov. 15–Jan. 1.	
In rest of State		Unprotected.
Quail or partridge, pheasant or grouse, wild turkey (see exception)		Nov. 1–Feb. 1.
Exception: West of the Blue Ridge	Nov. 1–Dec. 31.	
Dove		Sept. 1–Dec. 15.
Duck, goose, brant,[4] Wilson snipe or jacksnipe, coot, mudhen, gallinules		Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs		Aug. 16–Nov. 30.

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[1] *Virginia:* Boards of supervisors may shorten the open season in their counties and make other restrictions not repugnant to law, "and may include in such protection other game not specifically mentioned in this section." (Code 1904, sec. 2070a, as amended in 1906.) These changes are not included in this table.

[2] Residents of the State may kill rabbits and squirrels on their own lands at any time.

[3] Residents of the State may kill squirrels on their own lands at any time.

[4] Wild fowl may not be hunted on Wednesdays, Saturdays, and Sundays on Back Bay, Princess Anne County.

Open seasons—Continued.	*Dates inclusive.*
Woodcock	Nov. 1–Dec. 31.
Rail, other than coot and gallinules	Sept. 1–Nov. 30.
Reedbird [1]	Aug. 16–Nov. 15.

No open season: Ringneck pheasant, Shenandoah (1920). By order of commissioner, approved by governor, introduced pheasants protected throughout State until September 1, 1920; in Brunswick County, November 1, 1921.

Hunting licenses: Nonresident, $10; alien, $20 (alien owner of real estate resident for five years, same as resident). Resident: State, $3; county of residence, $1. Issued by clerks of circuit and corporation courts.

Nonresident may hunt on own land during open season without a license. Owner, members of family, and tenant of land residing thereon may hunt without license during open season on own or adjoining lands with consent of owner.

Bag limits and possession: Twenty-five ducks, 8 geese, 8 brant a day, but not more than 35 in all a day in Back Bay, Princess Anne County; 15 in all of plover and yellowlegs, 25 Wilson snipe, 6 woodcock, 50 sora and 25 in all of other rails, coot, and gallinules, 25 doves. Possession of migratory birds permitted during first 10 days of close season.

Local bag limits are as follows: In Shenandoah County, 15 quail or partridges, 3 pheasants or grouse, and 2 wild turkeys a day. In Brunswick County, 15 quail and 2 turkeys a day.

Sale: Sale of quail or partridge, grouse or pheasant, wild turkey, reedbirds, and all other migratory birds prohibited.

Export: Export of all protected game (except waterfowl legally killed) is prohibited; provided that during open season nonresident may, under his hunting license, take with him out of State, or as baggage on same conveyance, 1 deer, 50 quail or partridges, 10 pheasants or grouse, 3 wild turkeys, and 25 of each or 100 in all of plover and snipe, if killed or captured by himself, shipped open to view, and plainly labeled with his name and address, but more than 2 days' limit of migratory birds shall not be exported by one person in any one calendar week from any part of State. Any citizen of State may ship from State, as a gift and not for sale (which fact must be stated on shipping tag), 1 deer, 18 quail or partridges, 6 pheasants, 3 wild turkeys, if open to view and plainly labeled with names and addresses of donor and donee and number of each kind of bird so shipped.

Back Bay, Princess Anne County: Nonresident licensee permitted to export as personal baggage 25 ducks, geese, or brant he has lawfully killed, but not for sale or barter, but not more than 16 geese or 16 brant in any one calendar week.

Shenandoah County: Licensee may take with him from county as personal baggage, open to view, if plainly labeled, 30 quail or partridges, 6 pheasants or grouse, 2 wild turkeys a season, and any citizen may ship the same quantity of game, as a gift, if not for sale.

WASHINGTON.

Open seasons:

West of Cascades—	*Dates inclusive.*
Deer (see exceptions), goat	Oct. 1–Nov. 1.
Exceptions: Deer in Island and San Juan Counties, Jan. 1, 1921; does in Skagit, Snohomish, and Whatcom Counties, no open season.	
Bear	Sept. 1–May 1.
Quail, ruffed grouse, native pheasant, Chinese pheasant (see exception), blue grouse, ptarmigan	Oct. 1–Oct. 15.
Exception: Chinese pheasant in Clallam, Kitsap, and Skamania Counties, no open season.	
Duck, goose, brant, coot	Oct. 1–Jan. 15.
Black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs	Oct. 1–Dec. 15.
Rail	Oct. 1–Nov. 30.
East of Cascades—	
Deer (Kittitas County, Oct. 15–Dec. 1)	Oct. 1–Nov. 15.
Bear	Sept. 1–May 1.
Goat	No open season.
Ruffed grouse (native pheasant), blue grouse (see exceptions)	Sept. 1–Nov. 15.

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[1] *Virginia:* See order of the Secretary of Agriculture, p. 77.

Open seasons—Continued.	*Dates inclusive.*
Exceptions: In Asotin (in precincts of Clarkston, South Clarkston, and West Clarkston, no open season), Garfield, and Walla Walla. Aug. 15–Oct. 1. *Ruffed grouse* in Kittitas and Yakima Counties, no open season. *Blue grouse* in Columbia County, no open season; in Spokane County, Oct. 1, 1919.	
Quail in counties of Asotin (in precincts of Clarkston, South Clarkston, and West Clarkston, no open season) and Garfield	Oct. 1–Oct. 10.
Prairie chicken in Stevens County	Sept. 15–Oct. 1.
Sharp-tailed grouse in Ferry and Okanogan Counties	Sept. 15–Nov. 1.
Sage hen, Hungarian partridge, male Chinese and English pheasants in Kittitas County	Oct. 1–Oct. 10.
Bob-white quail in Spokane County	Oct. 1–Nov. 1.
Hungarian partridge in Lincoln, Spokane, and Stevens Counties	Oct. 1–Nov. 15.
Chinese pheasants in Benton, Stevens, and Yakima Counties	Oct. 1–Oct. 15.
Duck, goose, brant, coot	Sept. 16–Dec. 31.[1]
Black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs	Oct. 1–Dec. 15.
Rail	Sept. 16–Nov. 30.

No open season: Moose, elk (1925); fawns, caribou, mountain sheep, squirrels (gray, black, fox), quail, prairie chicken, sage hens, introduced birds (except as above), turkey, and dove.

Hunting and fishing licenses: Nonresident: Hunting, $10; fishing, county, $2. Resident: State, $5; county, $1. Issued by county auditors.

No license required of honorably discharged Union soldiers of Civil War to hunt or fish, or of women and persons under 16 to fish, if residents.

Bag limits and possession: One deer in counties east of Cascades. Two deer (1 buck in Skagit, Snohomish, and Whatcom), 1 goat in counties west of Cascades.

Five in all of partridge, grouse, prairie chickens, Hungarian partridge, Chinese or English pheasant a day or in possession; 10 quail a day; 10 upland birds, but in no event to include more than 5 upland birds other than quail, and 25 in all of upland birds a week. In Kittitas County 2 male Chinese or English pheasants in bag of 5 upland birds; 20 ducks, geese, brant, golden plover, yellowlegs, Wilson snipe a week (week ends at midnight Saturday), but not more than 8 geese, 8 brant, 15 in all of plovers and yellowlegs a day; 30 ducks, geese, brant in possession; 50 sora and 25 in all of other rails, coots, and gallinules. Possession during close season permitted under permit, but migratory birds shall not be possessed longer than first 10 days after close of open season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited.

WEST VIRGINIA.

Open seasons:	*Dates inclusive.*
Rabbit (except on own land at any time)	Oct. 1–Dec. 31.
Squirrel	Sept. 15–Nov. 30.
Ruffed grouse (pheasant)	Oct. 15–Nov. 30.
Quail (Virginia partridge)	Nov. 1–Nov. 30.
Duck, goose, brant	Oct. 1–Dec. 31.
Coot, gallinules	Sept. 16–Dec. 31.
Wilson snipe or jacksnipe	Oct. 15–Dec. 14.
Black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 14.
Woodcock	Oct. 1–Nov. 30.
Rail (ortolan) other than coot and gallinules	Sept. 1–Nov. 30.

No open season: Deer (1922); elk (1927); wild turkey (1921); dove, imported pheasants, capercailzie, and other introduced foreign game birds.

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[1] *Washington:* No open season on waterfowl on Columbia or Snake Rivers or within one-fourth mile of their shores in counties of Benton, Columbia, Douglas, Franklin, Garfield, Grant, Kittitas, Klickitat, Walla Walla, Whitman, and Yakima.

Hunting licenses: [1] Nonresident, $18; resident, $1; issued by county clerk. Aliens not permitted to hunt. License issued to minor under 15 on consent of parent or guardian. Unlawful to hunt on inclosed or improved lands without written permission of owner.

Bag limits and possession: Ten squirrels a day, 70 a season; 12 quail a day, 60 a season; 5 ruffed grouse a day, 20 a season; 25 ducks, 8 geese, 8 brant, 6 woodcock, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coot, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 20 days thereof.

Sale: Sale prohibited of all protected game, except rabbits may be sold during open season.

Export: Export prohibited of deer, venison, squirrel, quail, ruffed grouse (pheasant), wild turkey, woodcock, geese, brant, ducks, plover, snipe. Not more than two days' limit of other migratory birds shall be exported by one person in any one calendar week.

Miscellaneous: Unlawful to discharge firearms across any public road, within 400 feet of any schoolhouse, or on the lands of another within 600 feet of an occupied dwelling house.

WISCONSIN.

Open seasons:	*Dates inclusive.*
Deer in Pierce, Barron, Eau Claire, Clark, Wood, Lincoln, Langlade, Shawano, Oconto, and all counties north thereof (except Marathon)	Nov. 21–Nov. 30.
In Marathon and rest of State	No open season.
Rabbit (see exception)	Oct. 15–Jan. 16.
Exception: In Columbia, Crawford, Grant, Richland, and Vernon Counties	Unprotected.
Squirrels (see exception)	Oct. 15–Jan. 1.
Exception: In Dodge, Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties	No open season.
Hungarian partridge in Jefferson and Waukesha Counties only	Sept. 7–Sept. 11.
Duck, coot or mud hen, gallinules	Sept. 16–Dec. 10.
Goose, brant, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 20.
Rails, other than coot and gallinules	Sept. 7–Nov. 30.

No open season: Elk, moose, quail, pheasants (Chinese, English, Mongolian), Hungarian partridge (except as above), woodcock, dove, swan, ruffed grouse, spruce hen, sharp-tailed grouse, prairie chicken (1921).

Hunting and fishing licenses: Nonresident: All game and fish, $50; all game (except deer) and fish, $25; fish, $1 (not required in outlying waters or of person under 16); settlers, $1; guide, $1. Issued by commissioner. Resident: Game, $1 (deer tag, 10 cents additional). Issued by county clerks.

Hunting licenses not issued to persons under 15 or to aliens. Hunting prohibited in fields of growing grain or on lands of another without consent of owner.

Bag limits and possession: One deer a season; squirrels, 5 a day; rabbits, 5 a day in counties where protected; other counties no limit; 2 Hungarian partridge a day; 8 geese, 8 brant, but not more than 10 in all a day. Duck (including coot or mud hen), plovers, snipe, rail, rice hen, 15 a day; mixed bag limit of 20 a day is permitted, but must not contain more than 15 of any one variety; 15 yellowlegs, but not more than 15 in all of plovers and yellowlegs a day.

Possession at any time of deer duly tagged permitted for private use by person killing it. Possession at any time prohibited of game by person without hunting license or scientist's certificate.

Sale: Sale of all protected game prohibited (except rabbit). Rabbits may be sold during open season.

Export: Export of all protected game prohibited, except nonresident licensee may transport, during last 10 days of November, 1 deer duly tagged if he accompanies shipment and may take in his personal possession, openly, a mixed bag of not more than 20 game birds legally killed, but not more than the bag limit for one day of any one variety.

Export permitted of specimens of birds and animals (except deer) taken under permits from State authorities and, if migratory birds are included, from Secretary of Agriculture, for scientific purposes. Park boards allowed to ship, under permit of State conservation commission, live animals and game birds for park purposes.

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[1] *West Virginia.*—**Fishing license: Nonresident, $5, issued by county clerk.**

WYOMING.

Open seasons:	*Dates inclusive.*
Deer (with horns)	Nov. 1–Nov. 30.
Elk in Lincoln, Park, and Fremont Counties (except between Roaring Fork Creek and Big Sandy River on west slope of Wind River Mountains in Bridger National Forest, and north of Big Wind River and south of Sweetwater River in Fremont County)	Oct. 1–Nov. 30.
Sheep (mature males) in Lincoln, Park, and Fremont Counties only	Oct. 15–Nov. 15.
Sage grouse	Aug. 15–Sept. 1.
Duck, goose, coot, gallinules, black-bellied and golden plovers, Wilson snipe, yellowlegs	Sept. 16–Dec. 16.
Rails other than coot and gallinules	Sept. 1–Nov. 30.

No open seasons: Elk (except as above), does and fawns, moose, antelope, quail, Mongolian pheasants (1925); grouse (other than sage grouse) (1923); dove.

Hunting and fishing licenses: Nonresident: General, $50; nonresident hunting big game must be accompanied by a guide, but not more than 3 may hunt under one guide; bear, $10; birds and fish, $5; fish, $3. Alien: Gun and fish, $25 (not required of holder of $50 hunting license or of persons engaged in herding sheep); fish, $3; resident alien, fish, $2. Resident: General, $2.50 (not issued to minor under 16); birds, $1 (not issued to minor under 14); fish, $1. Guide: Citizen only, $10 (bond, $500—may guide party of 3 nonresidents at one time). Licenses issued by justice of peace and assistant and deputy wardens. Unlawful to hunt on inclosed lands of another without consent of owner.

Bag limits and possession: One deer, 1 elk, 1 sheep, a season; 18 birds, of which not more than 4 may be sage hens (2 sage hens in Laramie and Sheridan Counties), a day or in possession, but must not include more than 8 geese, 8 brant, or 15 in all of plovers and yellowlegs.

Sale: Sale of all game of State prohibited; provided, the sale of game (except edible portion) is permitted when properly tagged. Justice of peace issues tags (fee, 25 cents) under affidavit that game was lawfully captured or killed. No sale of migratory birds permitted.

Export: Export of all protected game prohibited; provided, game may be exported if properly tagged by a justice of the peace, fee 25 cents. Game tags issued under affidavit of lawful killing, and, if edible portion, that it is not for sale. Smithsonian Institution or other well-known scientific institutions may export any game animals or birds under permit of State game commission. Exchange of game animals and birds for liberation in Wyoming allowed under permit of the State game commission. Not more than 50 ducks, 16 geese, 16 brant, 50 Wilson snipe, 30 in all of plovers and yellowlegs, or 50 in all of rails, coots, and gallinules shall be exported by one person in any one calendar week.

CANADA.

Under the act of August 29, 1917, to give effect to the migratory-bird treaty between the United States and Great Britain the governor general in council has promulgated regulations for the protection of migratory birds in Canada.[1] These regulations restrict the hunting of migratory game birds not protected throughout the year to a period not exceeding 3½ months between September 1 and January 15, inclusive, in all except the Maritime Provinces, where the 3½ months open season on shorebirds opens August 15 and closes November 30. Other provisions of the regulations also conform to the terms of the treaty.

In 1919 the above-mentioned act was amended so as to authorize the governor general in council to make regulations fixing the bag limits on migratory game birds, and prescribing the manner in which they may be taken and the appliances that may be used therefor.

Canada also has a general law prohibiting export of deer (except those raised on private preserves), wild turkey, quail, partridge, prairie fowl, and woodcock, but permitting each nonresident to export two deer (except in those Provinces further limiting the number) in a year at certain ports within 15 days after the close of the open season, under permit of the collector of customs of the port from which export is made. The ports of export are Halifax and Yarmouth, Nova Scotia; Macadam Junction, New Brunswick; Quebec and Montreal, Quebec; Ottawa, Kingston, Niagara Falls, Fort Erie, Windsor, Sault Ste. Marie, and Port Arthur, Ontario; and such others as the minister of customs may designate.

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[1] Full text of the regulations will be found on pages 77–80.

ALBERTA.

Open seasons: [1]	*Dates inclusive.*
Deer (male), bull moose, caribou	Nov. 1–Dec. 14.
Sheep (male), goat	Sept. 1–Oct. 31.
Grouse, partridge, prairie chicken, ptarmigan	Oct. 1–Nov. 14.
Hungarian partridge	Oct. 1–Oct. 31.
Duck, goose, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs, rails, and coot	Sept. 1–Dec. 14.

No open season: Elk or wapiti, buffalo, females of deer, moose, sheep, young of all big game, antelope (1925), Hungarian pheasant.

Hunting licenses: Nonresident: General, $25; bird, $5. Resident: Big game, $2.50; birds, $2.25 (required only south of Lat. 55°); not required of farmer or member of family residing with him on farm; guide, camp help, $2.50; market hunter, $5; game dealer, $10. Farmers or their sons residing on own land, big game, $1. Issued by minister of agriculture. Residents north of latitude 55° may also take one head of big game (except elk or buffalo) without big-game license.

Bag limits: Deer, moose, caribou, 1 of each species, 2 sheep, 2 goats a season; grouse, partridge, prairie chicken, ptarmigan, 10 a day, 100 a season; Hungarian partridge, 5 a day, 25 a season; 30 ducks a day, 200 a season.

Sale: Sale of grouse, partridge, prairie chicken, ptarmigan, Hungarian partridge prohibited. Other game birds may be sold under license during open season. The flesh of big game may be sold under $10 license. Heads of big game before being sold must be stamped by minister of agriculture at fee of $5 for elk, caribou, moose, sheep; and $2 for deer, antelope, and goat.

Export: Export of all protected game prohibited, except minister of agriculture may grant permits for export of game at the rate of $5 for each head of big game and $1 per dozen for game birds. The holder of a general nonresident license may take with him out of the Province as trophies heads, skins, and hoofs of big game legally killed by him. Any person may export mounted or branded heads at a fee of $1 for each head. Export of migratory birds prohibited during close season.

BRITISH COLUMBIA.[2]

(1919 regulations not received.)

Open seasons.[2]

No open season: Buffalo, elk, young of deer and goat, and females and young of moose, caribou, and sheep.

Hunting and fishing licenses: Nonresident: General, $25 and $25 additional for each grizzly bear, moose, sheep, wapiti, or caribou, $15 additional for each black or brown bear, mountain goat, or mule deer, and $5 additional for every deer of any other species shot by him; birds (season), $50; bear, Jan. 1–July 1, $25; angling, season $5, or $1 per day up to five days; British subject, birds, $5 per week. Resident and members of army, navy, or militia on duty in Province: Deer and birds, $2.50; big game and birds, $5. Big game, birds, and trapping, $10; guide, $5. Issued by warden or any person authorized by him.

No fee required of farmer holding over 10 acres of land or member of family for license to hunt birds and deer on land on which he resides. Free license granted to prospector under certain conditions upon production of free miner's certificate. No license issued to person under 16 without written consent of parent or guardian, and then to hunt with firearms only under supervision of licensed adult. Unlawful to hunt on cultivated, cleared, or inclosed land without owner's consent.

Badge to be worn by licensee. Firearms not to be carried without license.

Bag limits and possession: Three deer of any species, 4 in all; 1 elk, 1 moose, 2 caribou, 2 goats, 2 sheep of any one species, 3 in all, 250 ducks a season. (Limits on other species fixed by orders in council.) Game may be possessed for two weeks after close of open season.

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[1] *Alberta:* North of latitude 55° any game animal or bird, except elk and buffalo, may be killed at any time if needed for food.

[2] *British Columbia:* Open seasons fixed annually by order in council, copies of which may be had from the secretary of the game conservation board, Victoria, British Columbia.

Sale: Sale prohibited of all game except under regulations of lieutenant governor in council.

Sale of big game without head attached and game birds without plumage prohibited. Heads of big game killed without and imported into Province may be sold when branded. Fees, moose and elk, $5; mountain sheep, $4; caribou, $3.

Export: Export prohibited of all protected game except under permit of Provincial game warden.

Miscellaneous: Use of automatic guns prohibited. Pump guns capable of holding only one cartridge in magazine may be used.

MANITOBA.

Open seasons:	*Dates inclusive.*
Deer, moose, caribou or reindeer, antelope or cabri (males)	Nov. 20–Dec. 10.
Ptarmigan	Oct. 1–Oct. 20.
Duck, goose, brant, coot, gallinule, Wilson snipe, black-breasted and golden plovers, yellowlegs, rail, and woodcock	Sept. 15–Nov. 30.

No open season: Bison or buffalo, elk, females and young of big game, dove; quail, pheasant, Hungarian partridge, introduced game bird (1927); grouse, prairie chicken.

Hunting licenses: Nonresident alien, big game, $25; birds, $25. Nonresident British, big game, $15; birds, $10. Resident, big game, $4; birds, $1. Issued by minister of agriculture. Hunting prohibited on inclosed or cultivated lands, lands covered by buildings or water, without consent of owner. No license required of farmers or members of family to hunt on farm on which they reside.

Bag limits and possession: One in all of deer, moose, caribou, and antelope a season; 15 ptarmigan a day, 50 a season; 20 ducks a day in September, 40 a day in October and November; 10 geese a day. Possession of ptarmigan allowed for 10 days after close of hunting season. Venison for private use may be possessed at any time on proof of legal killing.

Sale: Sale prohibited of deer, elk, moose, caribou, antelope (except heads and hides), and all protected game birds.

Export: Export prohibited of all protected game except under permit issued by department of agriculture. No permit shall be issued for export of ptarmigan, prairie chicken, partridge, grouse, geese, ducks, or entire carcass of any moose, elk, caribou, or deer; provided, nonresident licensee under permit issued free may export carcass of moose, caribou, or deer, and not more than 50 geese and 50 ducks killed by him. (No duck shall be exported before Oct. 1.) Export of migratory birds prohibited during close season.

Miscellaneous: Hunters must wear complete outer suit and cap of white material. Automatic guns prohibited in hunting waterfowl and ptarmigan.

NEW BRUNSWICK.

Open seasons:	*Dates inclusive.*
Deer (see exception), moose (bulls)	Sept. 15–Nov. 30.
Exception: Deer on Grand Manan and Campobello Islands	Oct. 1, 1922.
Waterfowl, rails, coot, gallinules	Sept. 1–Dec. 14.
Woodcock, jacksnipe or Wilson snipe	Sept. 15–Nov. 30.
Black-breasted and golden plovers, yellowlegs	Aug. 15–Nov. 30.

No open season: Caribou (1921); calf under 3 years and cow moose; pheasant; partridge (1921).

Hunting licenses: Nonresident: General, $50; bird, $10; Westmoreland County, $25; fish, $5. Resident: Big game, $2; sinkbox for waterfowl, $1; taxidermist, $1; guide, $1; camp help, $1. Big game license not issued to person under 18. Issued by minister of lands and mines. Nonresident licensee must have registered guide.

Bag limits and possession: Two deer, 1 moose (lumber camp limited to 2 moose) a season; 20 ducks, 10 partridges, 10 woodcock a day. Game may be kept for personal use in cold storage during close season under permit.

Sale: Sale of carcass of moose and deer (except head or hide) prohibited; woodcock until September 15, 1919; of other game during close season; provided game (except migratory birds) may be sold during life of 10-day permit applied for within 10 days after close of season. Keepers of hotels, inns, etc., may serve game during open season and 15 days thereafter. Dealer under $1 license from minister of lands and mines may sell three deer at retail and heads and hides to taxidermists; and hides and skins of animals may be sold under license by nonresidents or aliens, fee, $25; and residents, fee, $2.

Export:[1] Export of all game prohibited, except that minister of lands and mines may issue license to export game alive or dead.

Miscellaneous: Automatic guns prohibited in hunting big game and waterfowl.

NORTHWEST TERRITORIES.[2]

Open seasons:[3]	*Dates inclusive.*
Deer and moose (males only), mountain goat	Sept. 1–Apr. 1.
Mountain sheep, caribou	Aug. 1–Oct. 1. Dec. 1–Apr. 1.
Partridge, prairie chicken, ptarmigan, and other grouse	Sept. 1–Jan. 1.
Waterfowl, rails, coot, gallinules, Wilson snipe, black-breasted and golden plovers, and yellowlegs	Sept. 1–Dec. 14.

No open season: Buffalo or bison; musk ox, wapiti or elk, does, cow moose; females of caribou, sheep, and goat with young, and young of any of such animals; swan (1928); eider duck (1923); woodcock. Hunting prohibited on Victoria Island.

Hunting and trapping licenses: Nonresident, $50; nonresident British subject, $25; resident, $2; trading or trafficking in game; nonresident, $100; nonresident British subject, $50; resident, $5. Issued by commissioner of Dominion parks. Native-born Indians, Eskimos, or half-breed bona fide residents of Northwest Territories may hunt without a license.

Bag limits: Two bull moose, 2 male deer, 4 caribou; mountain sheep, 2 of any species, 3 in all; mountain goat, 2 of any one species.

Sale: Sale of protected game during close season prohibited.

Export: Export of the meat of any game prohibited.

NOVA SCOTIA.

Open seasons:	*Dates inclusive.*
Deer, male (except on Cape Breton Island, no open season)	Oct. 16–Oct. 31.
Moose, bulls (except on Cape Breton Island, no open season)	Oct. 1–Nov. 30.
Caribou, bulls, in Inverness and Victoria Counties only	Sept. 16–Oct. 15.
Hare, rabbit	Dec. 1–Feb. 1.
Waterfowl, rails, coot, gallinules	Sept. 15–Dec. 31.
Black-breasted and golden plovers, yellowlegs	Aug. 15–Nov. 30.
Woodcock, Wilson snipe	Sept. 1–Dec. 14.

No open season: Females and young of deer, moose, and caribou, Canada grouse (spruce partridge), pheasant; ruffed grouse (birch partridge), 1922.

Hunting licenses: Nonresident: All game, $30; birds and small game, except woodcock and snipe, $15; nonresident paying taxes equal to license fee, $5; resident alien, $5; guide, resident, $2. Issued by provincial secretary, game commissioners, and county clerks.

Bag limits: One moose a season; 5 ruffed grouse, 10 woodcock a day.

Sale: Sale prohibited of deer, caribou, pheasant, blackcock, capercailzie, Canada grouse (spruce partridge), chukar partridge.

Moose (meat only) may be sold from October 4 to November 1 under certificate showing lawful killing; rabbit, December 4 to February 1; any game bird other than those above mentioned during the open season, with the exception of the first three days.

Export: Export prohibited of all protected game, except holder of nonresident general license may ship out of Province under license tag 1 moose lawfully shot by himself. Mounted heads and dressed skins and live mammals or birds for propagating or scientific purposes may be exported under permit from chief game commissioner.

Miscellaneous: Unlawful to use rifle or gun loaded with bullet to shoot wild fowl.

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[1] *New Brunswick:* Except in the case of partridge the prohibition applies only to common carriers.

[2] "*Northwest Territories*" means the northwest territories formerly known as Rupert's Land and the Northwestern Territory (except such portions thereof as are included in the Provinces of Ontario, Quebec, Manitoba, Saskatchewan, and Alberta and the Yukon Territory), together with all British territories and possessions in North America and all islands adjacent thereto not included within any Province, except the Colony of Newfoundland and its dependencies.

[3] Indians, Eskimos, bona fide inhabitants, explorers, and surveyors may take game, except musk ox or elk, and the eggs of birds when actually needing them to prevent starvation. Indians and Eskimos may take musk ox for such purposes.

ONTARIO.

Open seasons:[1]	*Dates inclusive.*
Deer	Nov. 5–Nov. 20.
Moose, caribou (bulls only) (cows and calves under 1 year of age, no open season)	Oct. 1–Nov. 30.[2]
Hare[3]	Oct. 15–Nov. 15. Dec. 28–Jan. 2.
Squirrel (black or gray)	Nov. 1–Nov. 15.
Wild turkey	Nov. 1–Nov. 15.
Woodcock	Oct. 15–Nov. 14.
Duck, goose, black-breasted and golden plovers, yellowlegs, jacksnipe or Wilson snipe, rail, coot, gallinule	Sept. 1–Dec. 14.

No open season: Fawns, elk or wapiti, dove, partridge, grouse, prairie fowl; capercailzie; quail, Hungarian partridge, pheasants (1920).

Hunting licenses: Nonresident: General, $25. Resident: Moose and caribou, $5; deer, $3. Guide, $2. Issued by department of game and fisheries.

Bag limits and possession: Resident, 1 deer; nonresident, 1 deer a season; 1 bull moose, 1 caribou a season; 200 ducks a season. Two or more persons hunting together under license may kill an average of 1 deer each. Possession permitted during open season and until March 31, following, of all game except migratory birds.

Sale: The sale of waterfowl prohibited; also partridge (grouse), quail, woodcock, and snipe prohibited to September 14, 1920. All other native game may be sold during the open season by the person killing it, and by dealers during open seasons and until the following January 1, under license. Hotels, restaurants, and clubs under license may sell during closed season. Imported game may be sold under special regulations and licenses. Game breeders may sell animals for breeding purposes under permit. Sale of migratory birds prohibited during closed season.

Export: The export of all wild game animals and birds is prohibited; provided, 1 deer, 1 bull moose, 1 bull caribou, and 100 ducks may be exported under nonresident hunting license if shipping coupon and, if required, affidavit of lawful killing be attached and contents of packages be open to view. Lawfully imported game and deer, moose, elk, or caribou in private ownership may be exported. Minister may issue permit for the export of game, dead or alive, at any time, except migratory birds during close season.

Miscellaneous: Use of automatic guns prohibited. Unlawful to enter with gun or dog into growing or standing grain without consent of owner.

PRINCE EDWARD ISLAND.

(1919 laws not received.)

Open seasons:	*Dates inclusive.*
Hare, rabbit	Nov. 1–Feb. 1.
Partridge (in alternate years, 1919, 1921, etc.)	Oct. 15–Nov. 15.
Waterfowl, rail, coot, gallinule	Sept. 1–Dec. 14.
Woodcock, jacksnipe or Wilson snipe	Sept. 15–Nov. 30.
Black-breasted and golden plovers, yellowlegs	Aug. 15–Nov. 30.

Hunting licenses: Nonresident, $15. If applicant pays taxes on real estate valued at $325, fee $5; sons and brothers of residents returning for visit, $2.50; guest, $2. Issued by game inspectors and tax collectors. Hunting on inclosed lands without permission of owner prohibited.

Bag limits and possession: No limits.

Sale: Game lawfully killed may be sold, except migratory birds may not be sold during close season.

Export: Export prohibited of all game except geese and brant; provided, nonresident licensee may carry out of Province 12 birds killed by himself if tagged and carried open to view. Export of migratory birds prohibited during close season.

Miscellaneous: Use prohibited of automatic, pump, machine gun, rifle, or other gun loaded with bullets in hunting game birds.

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[1] *Ontario:* Lieutenant governor in council may alter close seasons in region north and west of French River, Lake Nipissing, and Mattawa River, and in the vicinity of Rondeau Park, and close for a definite period seasons for any game animal or nonmigratory game bird whose numbers have diminished.

[2] South of the Canadian Pacific R. R. from Mattawa to Port Arthur, Oct. 5–Nov. 20.

[3] Hares may be killed during close season by any means other than shooting.

QUEBEC.

Open seasons:[1]

Deer, bull moose (see exception)	Sept. 1–Dec. 31.
Exception: In Labelle, Ottawa, Pontiac, and Temiscaming Counties	Oct. 1–Nov. 30.
Caribou	Sept. 1–Jan. 31.
Hare	Oct. 15–Jan. 31.
Bear	Aug. 20–June 30.
Birch or swamp partridge	Sept. 1–Dec. 14.
White partridge or ptarmigan	Nov. 1–Jan. 31.
Waterfowl, rails, coots	Sept. 1–Dec. 14.
Woodcock, jacksnipe or Wilson snipe, black-breasted and golden plovers, yellowlegs (see exceptions)	Sept. 1–Dec. 14.
Exceptions: In Bonaventure, Gaspe, Rimouski, and Saguenay Counties	Aug. 15–Nov. 30.
In districts adjacent to tidewater	Sept. 1–Nov. 30.

No open season: Cow moose, young of deer, moose, and caribou, eider duck, pheasant (1920).

Hunting licenses: Nonresident: General, $25 (members of incorporated hunting clubs, $10). Resident, $1 (not required of resident British subject hunting for own use); resident special, $5 (3 deer and 3 caribou additional to limit). Issued by Minister of Colonization.

Bag limits and possession: Two deer, 1 moose, 2 caribou in season; 3 caribou and 3 deer under special resident license. Game lawfully killed may be possessed until 15 days after close of open season.

Sale: Sale of birch or spruce partridge prohibited until October 1, 1920. Game lawfully taken may be sold from the third day of open season to and including the fifteenth day after expiration of open season. Licensed hotels, restaurants, and clubs may serve game lawfully taken, except birch or spruce partridge. Sale of migratory birds prohibited during close season.

Export: Export of moose, caribou, and deer, or parts thereof, prohibited except under permit issued from Minister of Colonization (fee not to exceed $5); also under tags attached to nonresident license not later than 15 days after close of season; export of migratory birds prohibited during close season.

SASKATCHEWAN.

Open seasons:[2]	*Dates inclusive.*
Deer, moose, caribou (males only)	Nov. 15–Dec. 14.[3]
Duck, goose, coot, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs, rails	Sept. 15–Dec. 31.

No open season: Antelope, buffalo, elk, and female of big game and young of big game under one year of age.[4] Partridge (ruffed grouse), sage grouse, Canada or spruce grouse, prairie chicken.

Hunting licenses: Nonresident: Big game, $25; birds, $15; domiciled in Canada, $5; issued by minister of agriculture. Resident, big game, $5; birds, $1.25 (required of resident of city or town). Issued by minister or agent. No license issued to person under 16 without written consent of parent or guardian. Big-game hunters must wear white suit and cap. Hunting prohibited on inclosed lands without consent.

Bag limits and possession: One moose, 2 deer, 2 caribou, but not more than 2 in all; 50 waterfowl a day, 250 a season. Game birds may be kept in licensed storage from

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[1] *Quebec:* By a Dominion order in council, it is unlawful to capture, take, injure, or molest migratory game, migratory insectivorous, or other migratory nongame bird, or to take, injure, destroy, or molest their nests or eggs within the following areas:

"A strip of land 10 feet in depth, along the cliff and the cliff itself on the north and east sides of Bonaventure Island in the County of Gaspe;

"The Bird Rocks and a 1-mile zone surrounding the same;

"Perce Rock and a 1-mile zone surrounding the same, except that where the mainland is distant less than 1 mile from Perce Rock, the shore of such mainland shall constitute the boundary of the zone."

[2] *Saskatchewan:* Lieutenant governor in council may extend close seasons over current year, within limits, on petition of six game guardians.

[3] Applies north of line between townships 34 and 35; south of said line no open season.

[4] Male moose having horns less than 6 inches in length deemed to be under one year of age.

September 16 to March 1 and flesh of big game from December 1 to April 1 if tagged with number and kinds of game, name of depositor, and number of his hunting license.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited; provided, minister of agriculture may grant permits to export for scientific purposes or propagation in public parks and zoological gardens 1 pair each species of big game and game birds upon payment of $5, or for propagation a specified number on application of another Province or State. Minister may issue permits to export deer (fee $2 per head) or other big game (fee $5 per head), hides of big game (fee $1 each), flesh of big game (fee $1 for each 20 pounds or less), birds (except grouse family) (fee $1 per dozen, limit 5 dozen per season). Nonresident licensee on leaving Province may take with him during open season personally under his license and permit big game and 100 game birds legally killed. Export of migratory birds prohibited during close season.

YUKON.

Open seasons:[1]	*Dates inclusive.*
Deer, moose, caribou, sheep, goat (males only)	Sept. 1–Mar. 1.
Partridge, prairie chicken, grouse, ptarmigan, pheasant	Sept. 1–Mar. 15.
Waterfowl, rails, coots, gallinules, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs	Sept. 1–Dec. 14.

No open season: Elk or wapiti, musk ox, bison or buffalo, and females of other big game.

Hunting licenses: Nonresident, $100. Issued by commissioner or game guardian.

Bag limits: Six caribou, 6 deer, 2 moose, 2 sheep, 2 goats a season.

Sale: Deer, moose, caribou, sheep, and goats lawfully taken may be sold during the open season and 60 days thereafter. Sale of migratory birds prohibited during close season.

Export: Protected game may be exported by a nonresident only under a hunting license and a shipping permit issued by the commissioner of the territory or a game guardian. Heads of game may be exported, if declared before a game guardian. Export of migratory birds prohibited during close season.

COLONY OF NEWFOUNDLAND.

Open seasons:[2]	*Dates inclusive.*
Caribou (except in a special region near Grand Lake, no open season)	Aug. 1–Sept. 30. Oct. 21–Jan. 31.
Hare, rabbits	Sept. 20–Jan. 1.
Ptarmigan, willow grouse or partridge, plovers, curlew, snipe, or "other wild or migratory birds (except wild geese)"	Sept. 20–Jan. 1.

No open season: Elk, moose.

Hunting and fishing licenses: Nonresident: Caribou, $51; fish (salmon and sea trout), $10.50. Resident, $5. Guide, nonresident, $50; resident, free.

Caribou licenses issued by minister of marine and fisheries, stipendary magistrate, or justice of peace.

Unlicensed guides not to be employed. Guide shall not guide party of more than three sportsmen.

Bag limits: Three caribou (stags) a season by nonresident licensee; 2 stags, 1 doe by resident.

Sale: Caribou may be sold from August 1 to January 1; ptarmigan, willow grouse taken in open season may be sold until January 15; other birds may be sold during open season.

Export: Export for sale prohibited of caribou, partridge, willow or other grouse; provided, minister of marine and fisheries may issue licenses to export caribou for breeding or scientific purposes. Licensee may export three stag caribou under hunting license and export permit (fee, 50 cents); resident may export antlers, head, or skin of caribou under export permit, but not, in either case, for sale.

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[1] *Yukon:* Indians, explorers, surveyors, prospectors, miners, and travelers in need of food may take game during close season. Commissioner in council may alter seasons.

[2] *Newfoundland:* Poor settlers may kill any birds except capercailzie and black game at any time for immediate consumption by themselves or their families.

DISPOSITION OF GAME RAISED IN CAPTIVITY.

Regulations have been adopted under the Federal migratory-bird treaty act to permit the propagation and sale of migratory waterfowl,[1] thus paving the way for the upbuilding in this country of an industry from which many persons have been barred by lack of suitable legislation. It has been demonstrated that game animals and birds, especially certain species of migratory waterfowl, will yield satisfactory returns when propagated on farms and preserves. It is believed that the demand will far exceed the supply for a number of years, in view of the increased restrictions on the sale of native wild game and of the fact that migratory birds can no longer be sold on the market anywhere in the United States unless they have been reared in captivity in accordance with the law and regulations. The Department of Agriculture, acting in conjunction with State game officials, will aid so far as possible in establishing this industry, both in preparing drafts of suitable laws to be enacted by the various States and in assisting breeders to obtain eggs and breeding stock. The Department is not and never has been in a position to furnish breeding stock or the eggs of any species of game bird for propagating purposes, contrary to frequent reports in the press, but it will assist legitimate enterprises by granting the necessary permits to propagate migratory waterfowl in captivity and to take birds or eggs for propagating purposes. Reasonable and proper regulations of Federal and State Governments will permit domesticated game to reach the market for consumption at all seasons and at the same time will prevent the infringement of laws to conserve the supply of native game.

Federal regulations: Under permit from the Secretary of Agriculture, Washington, D. C., and subject to the provisions of State laws relating thereto, migratory waterfowl may be possessed, sold, and transported at any time for propagating purposes and the unplucked carcasses and the plucked carcasses with heads attached of propagated birds killed in any manner, except that they may be killed by shooting only during the open season for waterfowl in the State where taken, may be sold and transported at any time to any person for actual consumption, or to the keeper of a hotel, restaurant, or boarding house, retail dealer in meat or game, or a club, for sale or service to their patrons, who may possess such carcasses for actual consumption without a Federal permit; provided, that no migratory waterfowl killed by shooting shall be bought or sold unless each bird before attaining the age of four weeks shall have had removed from the web of one foot a portion thereof in the form of a "V" for identification purposes. (See Reg. 8, p. 74, for full details and requirements.)

About two-thirds of the States now have some special provision regulating possession, sale, or export of game raised in captivity. The following table giving a digest of the various State laws on the subject serves to show the lack of uniformity and the need of additional legislation to attain the results desired:

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[1] Waterfowl are the only migratory birds that are permitted to be raised in captivity, and permits therefor must be obtained from the Secretary of Agriculture, Washington, D. C., in accordance with the regulations. (See pp. 74–75.)

Arkansas: The commission may establish rules governing propagation of game in captivity and authorize the sale or export of such game under permit.

California: Game raised in captivity under breeder's license (fee, $2.50) may be sold at any time for breeding purposes or may be sold under license and regulations of commissioners for food when properly tagged (fee, 3 cents a tag). All domesticated game (except deer) must be killed otherwise than by shooting.

Colorado: Game furnished from a private park or lake of class A may be sold by hotels and restaurants at any time. Game taken from licensed private parks may be sold or shipped at any time if accompanied by an invoice.

Connecticut: Deer, pheasants, and wild fowl raised in licensed preserves (fee, $2) may be sold or transported at any time, when duly tagged under regulations of commissioners of fisheries and game.

Delaware: Unlawful to kill, sell, or possess Hungarian partridge or pheasants except for scientific or propagating purposes.

Georgia: Registered breeder may sell game for propagation.

Illinois: Game raised in captivity under a breeder's license (fee, $5) may be sold for propagation purposes, or may be killed, sold, and transported for food at any time.

Indiana: Game raised in captivity may be killed, sold, or transported at any time.

Iowa: Game birds raised in captivity under license (fee, $2) may be sold.

Kansas: Game raised in captivity may be transported for scientific or propagating purposes under permit of warden and $1,000 bond.

Kentucky: Game birds and game animals bred in captivity under permit may be sold, transported, or otherwise disposed of at any time when duly tagged.

Louisiana: Game raised in captivity under $5 license may be sold alive for stocking or breeding purposes, and may be killed, transported, and sold for food at any time, if tagged with metal tag. Traffic in birds killed by shooting prohibited.

Maine: Game raised in captivity under a $2 breeder's license may be killed, sold, or transported at any time under regulations of commissioners.

Maryland: Elk and imported and native deer raised in licensed preserve (fee, $5) may be sold, dead or alive, at any time. (In Allegany and Garrett Counties white-tailed deer native to the State must be branded three months prior to killing.) The propagation and killing of English or ringneck pheasants in captivity is permitted. In Washington County game animals and birds reared in licensed preserves (fee, $10) may be sold for propagation only.

Massachusetts: Quail reared in captivity under permit may be exported. Game may be reared in captivity under license (no fee) and sold for propagation under regulations of commissioners; deer, elk, pheasants, quail, European or gray partridge, and wild fowl may be reared in captivity under license (no fee) and sold for food, when properly tagged. Tag fee, 5 cents. Licensed dealers may sell such game.

Michigan: Deer, elk, pheasants, and wild ducks may be raised in captivity under $5 license and sold at any time for breeding or stocking purposes and the carcasses transported or sold for food when properly tagged (fee, 5 cents). Ducks killed by shooting[1] (except under direct supervision of a deputy warden) may not be sold or disposed of. Licensed retail dealer, club, hotel, restaurant, etc., may sell portion of tagged game to patron or customer for actual consumption or use without additional license.

Minnesota: Game raised in captivity under license (fee, $1) may be sold alive at any time for propagating purposes, and may be killed, sold, and transported under regulations of commissioner. No fee required to raise game birds for domestic use or as pets.

Missouri: Deer, elk, and other protected game raised in captivity under license (fee, $5) may be transported and sold under regulations of the commissioner.

Montana: Game raised in licensed private preserve (fee, $5) may be killed, sold, or transported at any time. If nucleus stock is captured from wild animals in the State, no such animals nor their progeny shall be sold for a period of three years.

Nevada: Game raised in licensed preserve (fee, $10) may be sold or shipped at any time under invoice.

New Hampshire: Game raised in captivity under $2 license may be sold or transported at any time when properly tagged, under regulations of commissioner.

New Jersey: Mallard, wood, and black ducks and Canada geese (when raised under Federal permit[1]), English and Mongolian pheasants, quail, ruffed grouse, deer, rabbits, and squirrels raised in licensed preserves (fee, $5) may be killed at any time, and if properly tagged (tag fee, 5 cents) may be sold for food or exported for sale. Live deer, on payment of $5 for each animal, and game birds may be exported for propagation.

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[1] *Michigan and New Jersey:* See Federal Regulation 8, p. 74.

New Mexico: Game raised in licensed preserve may be exported or sold at any time, under invoice, if the number of animals or birds in the park at the time the license is secured is not thereby reduced.

New York: Elk, white-tailed deer, European red deer, fallow deer, roebuck, pheasants, Canada geese, Hutchins geese, mallard, and black ducks raised in captivity under license may be sold for breeding purposes and may be killed, sold, or exported at any time under license when properly tagged. Said ducks and geese may be killed by shooting during open season only, but ducks and geese[1] killed by shooting may not be sold, except under regulations of commission. Varying hares and cottontail rabbits bred in captivity under $5 license may be sold for food during close season, when properly tagged, under rules and regulations of the conservation department.

North Carolina: Twenty-two counties have laws in regard to certain game raised in captivity.

North Dakota: Board may issue permits to breed or domesticate game.

Ohio: Ringneck, Mongolian, or Chinese pheasants and mallard and black ducks raised in captivity under a breeder's license (fee, $5), may be sold for propagation and may be killed and sold when duly tagged. No pheasant, mallard, or black duck raised in domestication shall be killed by shooting except during the open season, and no mallard or black duck killed by shooting shall be bought or sold unless it shall have had a well-defined V-shaped section removed from the web of one foot before it attains the age of four weeks. Packages must be labeled to show the number and kinds of birds contained therein, together with the name and address of the consignor.

Deer, squirrels, and rabbits may be possessed in inclosures as pets.

Oklahoma: Game raised under license (fee, $2) may be transported for propagation at any time, and for food, when properly tagged, during season prescribed by commissioner.

Oregon: Game birds and animals raised in captivity under permit (fee, $2), may be exported or sold at any time upon being properly tagged by commissioner or deputy. Tag fee, 5 cents each. Written permit from commissioner must be attached to each shipment. Packages containing game to be plainly labeled.

Pennsylvania: Game breeder's certificate, fee $1, bond $500. Game raised in captivity may be sold alive or dead within the State.

Rhode Island: Game raised in captivity under permit may be sold at any time for propagation, under regulations of commissioners.

South Carolina: Any birds or animals protected by law may be kept in possession for purposes of propagation or domestication.

South Dakota: Game raised in captivity may be exported or sold under written permission of State game warden.

Utah: Game raised in licensed private preserves (fee, $25) may be sold when duly tagged. Fifty birds and ten animals of each kind may be captured, under permit of commissioner, for propagating purposes.

Vermont: Game raised in licensed private preserves (fee, $2) may be exported at any time when duly marked and tagged, and may be sold for propagation at any time, or for food, under tag in accordance with regulations of commissioner.

Virginia: Game animals and birds raised under breeder's license (fee, $25) may be disposed of at any time for propagating or other purposes. Packages containing animals or birds transported for propagating purposes must be marked to show clearly the names of consignor and consignee and that they are being transported for propagating purposes. Carcasses of game animals or birds must be tagged (fees, smaller birds and animals, 2 cents; wild turkeys, 10 cents; deer, bear, or elk, 50 cents). Proprietor of hotel or restaurant or a dealer may sell under a $5 license to guests or patrons game raised in captivity. (No license required of keeper of hotel or restaurant or a dealer to sell, during open season, waterfowl and rabbits raised in captivity or other species of propagated game the sale of which is not prohibited.)

Holder of a game breeder's license, under permit and regulations of the commissioner, may trap wild animals or birds for breeding purposes, but the animals or birds so taken shall not be sold or otherwise disposed of.

Washington: Game and fur-bearing animals and wild birds may be raised in captivity under license (fee, $10) and sold and transported for food or propagating purposes when properly tagged. Keeper of hotel, restaurant, boarding house, or club, and retail dealer in meats, when duly licensed (fee, $5), may sell carcasses or parts thereof when properly tagged. Under proper permit from State game warden, animals and birds may be captured on State game preserves or imported from another State or country for propagating purposes.

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[1] *New York:* See Federal regulation 8, p. 74.

West Virginia: The owner of elk kept in inclosure may kill them at any time, and may pursue and recapture, by killing or otherwise, elk which have escaped from his inclosure. Tame deer may be killed by the owner.

Wisconsin: Under permit and supervision of the commission wild animals may be taken and transported for propagation within the State.

Wyoming: Natural increase of big game (except moose) captured under permit (fee, $1) and held for propagation may be exported or sold.

NEW LAWS PASSED IN 1919.

(For correct seasons for hunting migratory birds and other game see "Summary of Laws Relating to Seasons, Licenses, etc.," pp. 7–47.

Federal.—Regulations: Amendments to regulations under the migratory-bird treaty act, prescribing September 1 to December 15 as the open season on black-bellied and golden plovers in Texas instead of November 1 to January 31; fixing a special bag limit of 50 a day on sora; removing restrictions on intrastate transportation of migratory birds; permitting migratory waterfowl raised in captivity to be killed by shooting during the open season for waterfowl in the State where taken, but providing that propagated waterfowl so killed shall not be sold unless each bird before attaining the age of four weeks shall have had removed from the web of one foot a portion thereof in the form of a V large enough to make a permanent well-defined mark to identify it as a bird raised in domestication under permit; permitting plumage and skins of migratory game birds legally taken to be possessed and transported at all times without permit; authorizing taxidermists under permit to possess, sell, and transport migratory birds and parts thereof legally taken; prohibiting the taking of migratory birds from any floating device towed by power boat or sailboat; prescribing Federal open season from September 1 to December 15 on doves in Arkansas, Indiana, Kansas, Nebraska, Ohio, and Utah; and fixing October 16 to January 31 as the open season on doves in Alabama, Florida, Georgia, and South Carolina, instead of September 16 to December 31.

On January 17, 1919, the Secretary of Agriculture issued an order permitting bobolinks, commonly known as reedbirds or rice birds, to be killed from half an hour before sunrise to sunset from September 1 to October 30, inclusive, in New Jersey, Pennsylvania, Delaware, Maryland, and the District of Columbia, and from August 16 to November 15, inclusive, in Virginia, North Carolina, South Carolina, Georgia, and Florida, but providing that the birds so killed shall not be sold, offered for sale, or shipped for purposes of sale, or be wantonly wasted or destroyed, but that they may be used for food purposes by the persons killing them and be transported to hospitals and charitable institutions for use as food. This order was issued after careful investigation by the Bureau of Biological Survey, which showed that bobolinks have been seriously destructive to the rice crops in the Southeastern States.

Alabama.—Four acts: Shortening the season three months and prohibiting summer shooting of squirrels (No. 52½); general act protecting fur-bearing animals, prescribing a $10 trapping license, and protecting bears and fixing an open season on them (No. 105); making hunting licenses expire September 30 instead of December 31 (No. 117); declaring all State lands to be forest reserves and game refuges and prohibiting hunting thereon (No. 138).

Alaska.—One regulation: Repealing regulation 6 which continued a close season until August 1, 1920, on moose in Southeastern Alaska south of the Lynn Canal; repealing the regulation prohibiting sale of moose meat north of latitude 62° between December 25 and August 19; modifying the regulation prohibiting sale of meat of moose, caribou, mountain sheep, and mountain goat south of latitude 62° and between longitude 141° and 155°, and limiting its application to the territory south of the Chugatch, or Coast Range, Mountains including the Kenai Peninsula, and thence east to longitude 141°; prohibiting use of jacklights, searchlights, or other artificial lights in hunting or killing deer or moose in Southeastern Alaska; prohibiting any game animal from being killed, sold, possessed, or procured for feeding foxes or other fur-bearing animals in captivity or dogs boarded for pay; repealing the regulation prohibiting sale or serving in boarding house, hotel, or other eating place of game killed by natives for food or clothing or by miners or explorers in need of food.

Arizona.—Two acts: Authorizing State game warden to make rules and regulations under which animals and birds which have become seriously injurious to agriculture may be taken or killed; providing a $2.50 trapping license; defining fur-bearing animals; protecting wild hogs and beavers until 1922, and prohibiting possession during close season; prohibiting possession of does and spotted fawns, and forbidding purchase or sale of deer hides from which evidence of sex has been removed; permitting hides of deer legally taken to be tanned or mounted (H. 237); establishing the Catalina Mountain State Game Preserve in the Coronado National Forest (H. 16).

Arkansas.—One act: General revision of game laws; lengthening season on deer one week and on turkeys three weeks; shortening season on quail one month and protecting squirrels and fixing an open season on them; requiring nonresident to obtain hunting license to take bear and increasing fee for hunting-dog license from $1.10 to $1.50; making State seasons and limits on migratory birds conform to Federal regulations; limiting the number of wardens to eight and taking from game wardens all police power, except such as they may derive by being deputized by county sheriffs (No. 276).

California.—Twelve acts: Prescribing a $10 hunting license for resident aliens who have taken out first papers (S. 72); prohibiting sale of tree squirrels (S. 303); increasing daily limit on Wilson snipe from 15 to 25 and weekly limit from 30 to 50; providing limit of 30 a week on doves (S. 306); declaring cottontail and brush rabbits to be predatory animals in game districts 4, 19, and 21 (A. 5); making it unlawful to shoot any kind of game bird or mammal except whale from power boat, sailboat, automobile, or airplane, or with a shotgun larger than No. 10 gauge (S. 305); adding districts 1–m and 3–e to the game-preserve districts in which taking predatory animals is prohibited without permit from the fish and game commission; permitting waterfowl to be taken in district 4–e (S. 380); permitting one day's limit of game birds and animals to be possessed during first five days of close season (S. 481); prescribing August 15 to September 15 as the open season on deer in district 4 instead of the month of September (S. 674); prescribing October 16 to December 31 as the open season on quail in districts 4 and 4½; shortening the season on doves one month by closing October 31 instead of November 30 (A. 575, S. 542); creating four new fish and game districts, two of which, Nos. 1½ and 4½, are hunting districts and two, Nos. 1–m and 3–e, are game-preserve districts (A. 664); reducing the maximum penalty for hunting in the Mount Tamalpais Refuge from $1,000 to $500 and imprisonment from 1 year to 150 days (S. 677).

Colorado.—Two acts: Prohibiting aliens from hunting, or from owning shotgun, rifle, or pistol (H. 348); creating the Colorado State Game Refuge in parts of Boulder, Larimer, and Grand Counties (S. 66).

Connecticut.—Eight acts: Requiring State board of fisheries and game to pay all moneys received under fish and game laws to State treasurer, to be credited to account of said board for its necessary expenses (ch. 43); protecting swans and permitting other wild fowl to be taken half an hour before sunrise (ch. 74); reducing bag limits on ruffed grouse, introduced pheasant, and Hungarian partridge (ch. 105); protecting ruffed grouse and female pheasant until October 8, 1920 (ch. 145); shortening the season two weeks on hares and rabbits, except Belgian or German hares, reducing the daily bag limit from 5 to 3, and the season limit from 35 to 30 (ch. 173); permitting deer to be killed only on agricultural lands when damaging fruit trees or growing crops, requiring that killing or wounding a deer must be reported to the commissioner within 12 hours, and prohibiting sale of flesh of deer taken in the State (ch. 201); making it unlawful to snare animals or to set snares or similar devices where animals can be taken (ch. 234); increasing maximum salary of superintendent of fisheries and game from $3,000 to $3,500 per annum (ch. 309).

Delaware.—Repealing the provision permitting a resident to sell, in his own county, game lawfully killed, thus prohibiting the sale of all game killed in the State except rabbits; adding turkey buzzard, crow, starling, and hawks (except fish hawk) to the list of unprotected birds; declaring all State, county, and municipal parks to be game refuges; prohibiting minor under 15 years of age from hunting with gun except when accompanied by an adult who is lawfully hunting; permitting nonresident who owns or leases property at any seaside summer resort, and his relatives, friends, and patrons sojourning at such resort, to hunt and fish in its vicinity from June 1 to September 30, without licenses during open seasons; prescribing September 15 to November 1 as the open season on squirrels instead of September 1 to October 15.

Florida.—Four local acts, relating to the protection of English pheasants and squirrels in Escambia County and squirrels in Holmes and Washington Counties.

Idaho.—Three acts: Creating a department of law enforcement with a bureau relating to fish and game under the supervision of a fish and game warden (chs. 8 and 65); creating a State game preserve in the Pocatello National Forest (ch. 25); providing for appointment of a field deputy at $1,600 per annum, with $1,000 for expenses, and increasing the number of assistant chief deputies from six to eight; increasing salary of State fish and game warden from $2,000 to $3,000 and his expense allowance from $1,000 to $1,800 per annum, and of the chief deputy from $1,500 to $2,000, but limiting his actual and necessary traveling expenses to $1,200; increasing salaries of assistant chief deputies from $1,200 to $1,600 and their expenses from $800 to $1,000 per annum each, and of the chief clerk from $1,500 to $1,800 per annum, and fixing the compensation of all other deputies at $125 per month in lieu of $3 per day; lengthening the season two weeks on elk in the principal counties having open seasons; prescribing an open season from August 15 to September 30 throughout the State on sage hens; reducing fee for general nonresident hunting license from $25 to $10, except to residents of adjoining States requiring a larger license fee, and on birds from $7.50 to $5; increasing fee for resident license from $1 to $1.50, but exempting women from license requirements; increasing the daily bag limit on ducks from 12 to 18, on doves and Wilson snipe from 6 to 12 each, and the possession limit on migratory birds from 15 to 20 birds a day; broadening the powers of officers authorized to enforce fish and game laws by requiring them to inspect depots, cars, warehouses, cold-storage rooms, warerooms, restaurants, hotels, lodging houses, and markets, and all baggage, packages, and packs held for storage, shipment, or sale, and authorizing them, without warrant, to search tents, wagons, autos, or other vehicles, camps, baggage, or packs believed to contain contraband game, birds, fish, or fur-bearing animals (ch. 65).

Illinois.—One act: Codifying and amending the game laws generally; adopting the Federal seasons on migratory birds but limiting the season on doves to the month of September; establishing a limit of 15 a day on rabbits and shortening the season two months, opening November 1 instead of September 1; reducing the limit on squirrels from 15 to 10 a day and the number in possession from 30 to 20; reducing the season five days on prairie chickens; limiting the number to 6 cock pheasants, 50 snipe, and 60 rails in possession; prohibiting shipment of game by parcel post.

Indiana.—One act: Creating a department of conservation with four commissioners and placing the game and fish interests of the State under its jurisdiction; providing for the appointment of chiefs of divisions, assistants, inspectors, and employees on fitness and merit, to be determined by examination or otherwise as the commission shall determine; empowering the conservation commissioners and each of the chiefs of divisions to administer oaths and to require public officials, corporations, associations, and individuals to furnish information for lawful purposes under the act, and authorizing them to subpœna witnesses, and require the production of books, records, etc.; giving to commissioners, chiefs of divisions, and all other legally appointed employees necessary police powers to enforce and administer the conservation laws; authorizing fish and game division to encourage and assist so far as practicable in the organization and establishment of fish and game protective associations in the State; providing a clerical fee of 10 cents for issuing hunting and fishing licenses, and directing that all expenses of the fish and game division shall be paid from the fish and game protective and propagation fund; providing that all funds accrued to the use of any division of the department other than regular or specific appropriations made by the general assembly shall constitute a revolving fund for the use of the respective divisions, and only that part of such funds in excess of $50,000 shall revert to the Treasury at the end of any fiscal year (ch. 60).

Iowa.—No game legislation.

Kansas.—One act: Extending absolute protection for 5 years on prairie chickens, partridge, and introduced pheasants; fixing the first 10 days in December as the open season on quail, making it unlawful to shoot them except on the wing, and prescribing a bag limit of 10 a day (ch. 207).

Maine.—Seven acts: Shortening the season one month on ruffed grouse and woodcock in eight southern counties (H. 308); increasing fee for resident taxidermists' license from $2 to $5 and prescribing a $25 taxidermist license for resident aliens (H. 285); shortening the season two weeks on deer in eight northern counties (H. 213); empowering commissioner, after thorough investigation, to grant permits to kill protected wild birds which have become seriously injurious to agriculture (S. 139); opening the season on bull moose during the last 10 days of November and requiring carcasses shipped to be tagged and to be accompanied and identified by owner at points designated by the commissioner; making it unlawful to sell or give away moose for shipment out of the State; providing a $5 shipping tag under which a resident may transport moose to his home or to a hospital in the State without accompanying shipment; allowing nonresident to transport to his home under hunting license and shipping coupons a bull moose, lawfully killed by him (ch. —); prohibiting carrying loaded guns in motor vehicles (ch. —); requiring resident hunters to procure certificates of registration, fee 25 cents, good as long as the holder remains a citizen of the State; making it unlawful to accept game for transportation without first ascertaining that shipper is duly licensed (ch. —); amending fish and game laws generally (clerical errors bill); prohibiting possession at any camp, lodge, or place of resort for hunters or fishermen, of any jacklight or light fitted for use in hunting game at night, or any swivel, pivot, or set gun; continuing the protection on caribou and prohibiting possession regardless of where taken; repealing the provision which allowed a resident to export one deer a season; prohibiting the use of deer and moose in lumber camps; prescribing a $25 nonresident license to hunt moose; providing that the fees for alien hunting licenses shall be paid into the appropriation for maintenance of fish and game department (ch. —).

Massachusetts.—Four acts: Protecting quail in Essex, Dukes, and Nantucket Counties until 1922 (ch. 40); extending the law prohibiting use of traps, nets, and snares for taking game birds to include all wild birds (ch. 65); prescribing a minimum penalty of $5 for taking game by use of traps, nets, snares, swivel and pivot guns, artificial lights, and power boats, and increasing the maximum penalty from $25 to $50 (ch. 88); protecting ruffed grouse, or partridges, until October, 1920; prescribing an open season on squirrel, quail, and woodcock from October 20 to November 20, instead of the month of November; and lengthening the season 10 days on hares, or rabbits, by opening October 20 instead of November 1 (ch. 153).

Michigan.—Five acts: Opening the season on fox squirrels during the last half of October and lengthening the season two weeks on woodcock, closing November 25 instead of November 9; prescribing different seasons for hunting rabbits in sections north and south of a line between townships 20 and 21 north; lengthening the season one month in the northern section of the State by prescribing a season from October 1 to March 1 and fixing the open season in the southern section from November 1 to March 1; allowing ruffed grouse to be hunted during October in the Upper Peninsula and November in the Lower Peninsula, the first grouse hunting permitted for several years (H. 203); making it unlawful for a person in or on any aircraft to pursue or molest game or insectivorous birds (H. 47); amending the act relating to taking deer by camping parties by authorizing, under $3 permit, camping party of six or not less than four licensed hunters maintaining a camp of at least four persons for not less than seven days to kill one deer for camping purposes (H. 34); protecting deer, moose, elk, caribou, beaver, muskrat, pheasant, grouse, partridge, and swan in or within 2 miles of any city public park containing over 200 acres of which 150 acres or more is woodland (S. 173); repealing the provisions which prohibited the use of a sneak boat when more than 50 decoys were used and which required decoys to be placed at least 1,000 feet from other decoys (H. 33).

Minnesota.—One act: Codifying and amending laws relating to fish and game; increasing term of office of commissioner from 2 to 4 years; prohibiting hunting within 3 miles of corporate limits of any city having a population of 50,000 or more (Duluth, Minneapolis, and St. Paul); increasing from 2 to 3 years the time within which prosecution may be commenced for violation of the game code; increasing from $25 to $50 nonresident or alien license fee to hunt game, and from $10 to $15 to hunt birds; prescribing open season on deer and bull moose from November 15 to December 5 instead of the last 21 days in November; lengthening the season 2 weeks on quail by opening October 15 instead of November 1; lengthening the season 1 month on migratory birds, thus making State open seasons coincide with Federal regulations; protecting prairie chicken and sharp-tailed grouse until 1922; and making it unlawful to carry a gun in a motor vehicle except when taken apart or carried in a case.

Missouri.—Two acts: Shortening the season one month on wild turkeys by opening December 1 instead of November 1; fixing the open season on woodcock from November 10 to November 30; providing a close season throughout the year on does; reducing the bag limit on turkeys from 2 to 1 a day, the number in possession from 4 to 2, and prescribing a limit of 4 a season; providing that 100 petitioning householders may obtain a referendum vote at a general election on the question of a two-year close season on quail in any county; increasing salary of game and fish commissioner from $2,500 to $3,000 per annum; authorizing employment of office deputy at $2,400 per annum and necessary clerks and stenographers at salaries not exceeding $100 per month; increasing compensation of deputies from $3 to $4 per day; enacting new license legislation and providing for combination hunting and fishing license, reducing nonresident fee from $25 to $10, and resident fee from $5 to $2.50; providing a separate $3 fishing license for nonresidents and $1 fishing license for residents, and permitting aliens to procure nonresident licenses to hunt and fish; permitting game birds to be raised in captivity and disposed of under regulations of the commission; appropriating $5,000 out of the game-protection fund to pay a bounty of 50 cents each on eagles, hawks, and horned owls; apppropriating $100,000 from the game protection fund for the State park fund (S. B. 445); abolishing the fish commission and directing the State fish and game commissioner to perform its duties; authorizing the commissioner to maintain a fish and game exhibit annually at the State fair in connection with the State fair board; and providing that not less than 20 per cent of the receipts of the game department shall be expended annually in the establishment and maintenance of fish hatcheries and the breeding of fish (H. B. 634).

Montana.—Six acts: Changing the open season on elk by opening the season in a few counties formerly in the list of preserve counties and fixing October 15 instead of October 1 as the earliest open season date (H. 89); closing the season until 1921 on deer, sage hen, prairie chicken, and grouse in Roosevelt, Sheridan, and Valley Counties (S. 154); providing that game specimens, including head, hide, scalp, or mounted specimen, may be sold under permit from State warden (H. 174); modifying the boundaries of the Gallatin Game Preserve (S. 109); reducing fee for game breeder's license from $25 to $5; permitting a limited number of wild animals and birds to be taken under permit from State warden for propagating purposes but prohibiting sale of progeny of such animals for a period of three years (S. 116); providing that all hunting licenses be conspicuously marked to show that they do not permit hunting within the boundaries of any national park in the State (S. 113).

Nebraska.— —— acts: Increasing the number of regular deputies from three to six and repealing the provision limiting the appointment of three deputies for four months at various seasons of the year; increasing protection afforded fur-bearing animals and prescribing trapping licenses, fees, $2 for residents and $10 for nonresidents or aliens; declaring school sections and educational lands with title vested in the State to be game reserves and bird refuges; authorizing commission to establish necessary reserves and refuges for the protection and propagation of game, and sanctuaries for song and insectivorous birds, and providing that a 5-acre tract for each 640 acres of land in a reservation may be planted to grains suitable for food for birds and game.

Nevada.—No game legislation.

New Hampshire.— —— acts: Repealing the special laws on deer in Cheshire, Hillsborough, Rockingham, and Sullivan Counties and prescribing a uniform season from November 15 to December 15 for deer in the State outside of Coos, Carroll, and Grafton Counties; prescribing a bag limit of 2 deer a season; reducing from 10 to 5 a day the limit on ruffed grouse and from 50 to 25 each a season on ruffed grouse and woodcock; increasing salary of commissioner from $1,800 to $2,500 per annum; permitting resident soldiers and sailors over 70 years of age to hunt and fish without license.

New Jersey.—Five acts: Protecting English, or ringneck, pheasants until 1924 (ch. 43); changing the season on deer from the last three Thursdays in October and the first Thursday in November to the five days beginning December 16 (ch. 45); adding Canada geese, ruffed grouse, rabbits, and squirrels to the list of game birds and animals which may be bred in captivity under a $5 breeder's license (ch. 65); requiring the marking of automobiles and vehicles owned by the State, but excepting cars used for the enforcement of fish and game laws (ch. 71); providing that compensation of head gamekeeper, and of superintendent of hatchery shall be fixed by the board of fish and game commissioners in accordance with schedules provided by the State civil-service commission (ch. 141).

New Mexico.—One act: Revising the fish and game laws generally; establishing a uniform State open season from October 20 to November 5 on deer and turkeys, thus shortening the season on deer 5 days in the northern district and 15 days in the southern, and on turkeys 6 weeks in the northern district to 15 days in the southern; shortening the season 1 week on quail and approximately 4 months on squirrels; making the open season on doves conform to Federal regulations; closing the season indefinitely on grouse; increasing in the sum of $5 the fees for nonresident general and big-game hunting licenses; increasing the daily bag limit on doves and ducks from 20 to 25; and increasing compensation of deputy wardens from $2 to $3 per day (ch. —).

New York.—Ten acts: Conforming provisions governing bag limits and possession in the State, and the season for migratory birds on Long Island, to the provisions of the Federal regulations (ch. 1); repealing the buck law and reducing the limit from two bucks a season to one deer of either sex in the Adirondacks (ch. 537); authorizing the conservation commission to license and maintain a register of competent guides for the forest preserve counties and to prescribe rules and regulations governing guides (ch. 538); increasing the entrance salary of game protectors from $1,000 to $1,200 per annum (ch. 539); repealing the special penalties prescribed for taking fish and game from private lands set aside as refuges (ch. 289); making it a misdemeanor to damage any bars, gates, or fences or occasion damage by leaving open any bars or gates while hunting on the land of another without permission (ch. 287); amending the law relative to importing game, and changing the nature of the offense for loaning, transferring, or altering a license from forgery in the second degree to misdemeanor (ch. 291); amending the game breeder's law to include Canada and Hutchins geese (ch. 230); adding crow blackbirds to the list of unprotected nongame birds and permitting red-winged blackbirds which are destroying crops to be killed from June 1 to September 30 by the owner or occupant of any lands upon which crops are being grown or by any person in his employ (ch. 258); repealing the provisions authorizing action for violation of the conservation law to be brought in any township in a county, and requiring that action be brought before a justice of the peace in the town in which an offense was committed or in an adjoining town (ch. 210).

Ohio.—One act: Codifying and amending the game laws generally; making it unlawful to kill deer; shortening the season 10 days on ruffed grouse, introduced pheasants, and Hungarian partridge, and permitting only cock pheasants to be taken; conforming State laws to Federal regulations for protecting migratory birds, prescribing daily limits of 3 on ruffed grouse and cock pheasants, 6 on Hungarian partridge, and 35 on sora; reducing the limit on plovers and yellowlegs from 12 each to 15 in all, and increasing the limit on Wilson snipe from 12 to 15 a day; repealing the provision prohibiting the hunting of waterfowl on Mondays (S. 45).

Oklahoma.—One act: Increasing salary of State game warden from $1,800 to $2,500 per annum, providing for an assistant game warden and license clerk at $1,800, and for a stenographer and bookkeeper at $1,200 in lieu of one stenographer at $900 and one bookkeeper at $1,000.

Oregon.—Three acts: Repealing the provisions limiting salary of State game warden to $2,400 per annum and the compensation of deputy wardens to $3 per day, and authorizing the board of fish and game commissioners to fix the compensation and expense allowances of its appointees; authorizing commissioners to make rules and regulations reasonably required in the administration of their duties; adding cranes, doves, and pigeons to the list of birds defined as game birds; protecting wood and eider ducks, the smaller shorebirds, and the migratory nongame birds mentioned in the migratory-bird treaty act; prescribing the months of September and October as the open season on deer west of the Cascades, except in Clatsop, Columbia, Multnomah, and Tillamook Counties, instead of the two months beginning August 15; lengthening the season two weeks on sage hens east of the Cascades by opening July 15 instead of August 1; repealing the special season on migratory game birds in Grant, Lake, Harney, and Malheur Counties, and the provision permitting hunting half an hour after sunset, as well as the provision, made obsolete by the migratory-bird treaty act and regulations, permitting the sale of geese killed in Crook, Gilliam, Harney, Morrow, Sherman, Umatilla, and Wasco Counties; prohibiting the shipment of game animals or birds unless a written permit from the commissioners is attached to the carcass or container; authorizing the State game warden to establish game refuges on private lands by contracting with owners (ch. 236); making a person guilty of a misdemeanor if his dog is found at large running or tracking deer or other game animal in Coos and Curry Counties (ch. 354); providing that free licenses issued to pioneer settlers or veterans of Indian and Civil Wars shall be good for life (ch. 364).

Pennsylvania.—Nine acts: Allowing 10 per cent clerk fees to salaried county treasurers for issuing hunting licenses (S. 141); authorizing the purchase of lands for game preserves and appropriating $100,000 for the first year and $50,000 a year thereafter, payable from the resident hunter's license fund, to carry out the purposes of the act (No. —); requiring persons of foreign birth to present naturalization papers when applying for resident hunting license (No. 213); providing a rebate of 25 per cent of the fine for illegal killing of does or fawns when voluntary acknowledgment of offense is made at once to the proper officer (No. 149); governing method of establishing and conducting auxiliary game preserves and enabling commissioners to propagate small game when desirable (H. B. 986); amending the county closing act so as to require at least 200 of the petitioners to give the numbers and dates of their hunting licenses (No. —); increasing from 60 to 80 the number of game protectors the board is authorized to appoint (No. —); removing protection from red squirrels and fixing the open season on blackbirds from August 1 to November 30 (No. 197); prescribing the open season on woodcock from October 1 to November 30 (No. —).

Rhode Island.—No game legislation.

South Carolina.—One act: Revising and amending the fish and game laws generally; adopting the Federal migratory-bird treaty-act regulations as the law of the State; repealing local laws and providing uniform seasons throughout the State on all species of game; repealing the provision exempting certain counties from the application of the resident license law, thus making it State wide; establishing a close season from March 15 to October 1 on bear, rabbit, and squirrel; shortening the season one month on quail; lengthening the season two weeks on wild turkey; reducing the bag limit on quail from 25 to 15 a day and establishing a limit of 20 turkeys a season (ch. —).

South Dakota.—Four acts: Authorizing the game and fish commission to acquire on behalf of the State public or private property by gift, devise, purchase, lease, or condemnation proceedings for the protection and propagation of game, birds, fur-bearing animals, and fish (H. 38); protecting fur-bearing animals and prescribing a $25 nonresident trapping license (H. 126); providing an open season from September 16 to October 15, instead of September 7 to October 6, on partridge, grouse, and prairie chicken; conforming State laws for protection of migratory birds to provisions of Federal regulations; increasing the limit on ducks from 15 to 25 a day, and the number of waterfowl allowed in possession from 25 to 50 (H. 163); prohibiting the training of bird dogs between April 1 and September 1 (H. 258).

Tennessee.—Twenty-one acts: Requiring a $2 special license in addition to the regular State license to hunt on Reelfoot Lake (ch. —); creating a game and fish preserve in Loudon County (ch. 406); local acts relative to game in the following counties: Benton (ch. 16); Carter (ch. 22); Claiborne (ch. 338); Cocke (chs. 14, 237); Franklin (ch. 204); Giles (ch. 375); Grainger (ch. 460); Greene (ch. 214); Hawkins (ch. 194); Hickman (ch. 34); Knox (ch. 568); Lawrence (ch. 509); McNairy (ch. 392); Marshall (ch. 457); Meigs (ch. 612); Obion (ch. 360); Union (ch. 11); and Warren (ch. 604).

Texas.—One act: Revising and amending the game laws generally; repealing the doe law and permitting deer of either sex to be killed during the open season; fixing the open season on turkey gobblers as March and April instead of December and January; protecting prairie chickens or pinnated grouse, pheasants, and woodcock until 1924; increasing the resident license fee from $1.75 to $2; requiring license for hunting outside of the county of residence and repealing provision permitting hunting without license in counties contiguous to county of residence; prescribing a special $2 boat license for persons carrying parties engaged in hunting; enacting provisions for the protection of migratory birds in conformity with the Federal regulations, and permitting possession of game during the open season and the first 10 days thereafter; authorizing commissioner to issue permits to kill birds and quadrupeds when necessary to protect crops from depredations; providing for the issuance of scientific collecting permits by the commissioner; authorizing appointment of special game commissioners at a maximum salary of $125 per month and expenses (H. 457).

Utah.—One act: Revising and amending the fish and game laws generally; repealing the $1.25 license to resident citizens and the $6 license to nonresidents, and prescribing a $2 license for all citizens of the United States to hunt and fish in Utah, thus abolishing the distinction between resident and nonresident hunters; governing the breeding and sale of game raised in captivity under a $25 license and tagging system; permitting 50 game birds and 10 animals to be taken for propagating purposes under permit from commissioner; permitting resident citizens to hunt buck deer during the first 10 days of November; creating the Dixie (Dixie National Forest), Fish Lake (Fish Lake National Forest), Heaston (Oquirrh Mountains), Cache (Cache National Forest), and the Strawberry State game preserves and prohibiting all hunting therein except the hunting of ducks during the months of October and November in the Fish Lake preserve; broadening the administrative powers of the commissioner and authorizing deputies without warrant to examine motor cars and trucks in the enforcement of the fish and game laws (ch. —).

Vermont.—Six acts: Authorizing the commissioner to establish such game refuges and sanctuaries as are recommended by the United States Bureau of Biological Survey; repealing the provision limiting the compensation of wardens to $3 per day when not continuously employed for periods longer than two weeks, and providing for the appointment of six deputy wardens at maximum salaries of $1,000 per annum (No. 181); protecting partridge or ruffed grouse until 1921 (No. 183); repealing the law protecting does, and changing the deer season from November 10 to November 20 to the week beginning the first Monday in December (No. 184); requiring copies of reports of wardens and selectmen on appraisals of damages caused by deer to be delivered to the claimant, who is allowed 10 days in which to appeal; reducing from 12 to 6 hours the time within which notice of the killing of a deer in defense of crops must be given to the nearest fish and game warden (No. 185); providing for the establishment, around commercial orchards having an area of 10 acres or more, of open zones within which deer may be killed at any time, but providing that no claim for damage by deer to orchards within open zones shall be allowed, and requiring that the killing of a deer within an open zone shall be immediately reported to the owner of the orchard and to the nearest fish and game warden (No. 186); prescribing a $10 bounty on black bears killed within the State from May 1 to November 1 (No. 190).

Washington.—One act: A comprehensive game-breeding law, prescribing a $10 game breeder's license (annual renewal fee, $5); permitting the sale of game animals or birds raised in domestication for propagating purposes and, when properly tagged, for food; and permitting dealers and keepers of hotels, restaurants, etc., under a $5 license, to sell propagated game.

West Virginia.—One act: Protecting deer until 1922, elk until 1927, and wild turkeys until 1921; lengthening the season on rabbits two weeks; increasing fee for nonresident license from $15 to $18, and prescribing a $1 resident State license in lieu of a $3 State license and a county license for which no fee was charged; decreasing the daily bag limit on squirrels from 12 to 10 and on ruffed grouse from 6 to 5; reducing the season limit on squirrels from 100 to 70, on quail from 96 to 60, on ruffed grouse from 25 to 20, and, after 1921, on wild turkeys from 6 to 5; providing for the expenditure of 20 per cent of the game protection fund in restocking streams of the State with fish; and limiting the payment of bounties on certain species of animals and birds to 10 per cent of the protective fund (ch. —).

Wyoming.—Three acts: Increasing salary of State game warden from $2,000 to $2,400 per annum, and his expense allowance from $1,500 to $2,000; reducing the number of assistant game wardens from seven to five, but increasing their salaries from $1,200 to $1,500 per annum and their allowances for expenses from $500 to $600 per annum; increasing maximum compensation of deputy game wardens from $4 to $5 per day; increasing salary of clerk to game warden from $1,200 to $1,500 per annum; authorizing bonded assistants and deputy game wardens to administer all oaths required by the provisions of the fish and game laws in addition to oaths administered in connection with issuance of hunting licenses; fixing September 1 to December 16 as open season on all migratory birds, except rails (not effective as it contravenes provisions of Federal migratory-bird treaty act and regulations); shortening the season two weeks on sage hens by opening August 15 instead of August 1, and protecting all other grouse until 1923; extending the close term on quail and Mongolian pheasants until 1925; reducing the daily bag limit on sage hens from 6 to 4; prescribing jail sentence of not less than 30 days or both fine and imprisonment in the discretion of the court for illegal killing of game birds; extending the close term on moose and antelope until 1925, and increasing the minimum jail sentence for illegal killing of these animals from 30 to 60 days; closing to elk hunting that portion of the Bridger Forest Reserve on the west slope of the Wind River Mountains between Roaring Fork Creek and Big Sandy River; shortening the season on elk two weeks by fixing October 1 to November 30 as the open season, and the season on mountain sheep six weeks by fixing October 15 to November 15 as the open season; abolishing the special hunting district for big game on the Fall River rim in the Wyoming National Forest, Lincoln County; reducing the season limit on elk from two to one, and abolishing the special $10 license to residents under which one additional elk was allowed to be taken; shortening the season two weeks on deer by prescribing the month of November as the open season, and permitting only male deer with horns to be killed; making clear that a nonresident may not trap bear under the special $10 nonresident bear-hunting license; repealing the provision authorizing issuance of hunting licenses to nonresidents or aliens paying $100 taxes in the State for the same fee paid by residents; providing that not more than three nonresidents may hunt big game under one guide; giving the district courts original concurrent jurisdiction in all game cases (ch. 55); modifying the boundaries of the Big Horn State Game Preserve (ch. 83); creating the Splitrock Special Game Animal Preserve and protecting moose, elk, antelope, deer, mountain sheep, and mountain goats therein (ch. 71).

CANADA.

Dominion legislation.—One act: Amending the migratory-birds convention act by authorizing the fixing of bag limits on migratory game birds for which an open season is prescribed, the manner in which they may be taken, and the appliances that may be used therefor; requiring officers seizing prohibited weapons and appliances or migratory birds or parts thereof taken or possessed contrary to law to deliver them to a justice of the peace, who may confiscate them; providing for the payment of half of penalties to any prosecutor other than a salaried game officer.

One regulation: Making it unlawful to take or molest migratory birds or their nests and eggs on three islands in the Gulf of St. Lawrence, namely, cliff along the east side of Bonaventure Island; and the Bird Rocks and Perce Rock Islands; and within a 1-mile zone surrounding these two.

Alberta.—One act: Fixing September 1 to October 31 as the open season on sheep and goats instead of September 1 to October 14, and fixing October 1 to November 14 as the open season on grouse and ptarmigan instead of the month of October.

British Columbia.—One act: Providing that the game conservation board shall consist of not less than five members (ch. 29).

New Brunswick.—One act: Authorizing the minister to select 400 square miles of wilderness Crown lands as a game refuge (ch. 23).

Nova Scotia.—One act: Fixing October 16 to October 31 as the open season on deer instead of October 21 to October 31; fixing October 1 to November 30 as the open season on bull moose instead of September 16 to November 30; fixing December 1 to February 1 as the open season on hares and rabbits instead of October 1 to April 30.

Ontario.—One act: Fixing November 5 to November 20 as open season on deer instead of the 15 days beginning November 1; reducing the limit on deer from two to one a season; abolishing the special $5 resident license to hunt caribou outside county of residence.

Quebec.—One act: Fixing September 1 to November 30 as the open season on shorebirds in districts adjacent to tidewater; permitting the eggs of birds to be taken under permit for scientific and propagating purposes; and prohibiting the export of the skins of moose, caribou, and deer on which the royalty has not been paid.

Saskatchewan.—One act: Establishing an indefinite close season for elk; continuing absolute protection indefinitely of all grouse except ptarmigan; prohibiting possession during close season of big game or game birds at or in the vicinity of any camp; making ex-officio game guardians all members of the Provincial police force in lieu of the Royal Northwest Mounted Police (ch. 55).

LACEY ACT, REGULATING INTERSTATE COMMERCE IN GAME.

Federal laws affecting the shipment of game comprise statutes regulating interstate commerce in game and the importation of birds and mammals from foreign countries, as follows:

ACT OF MARCH 4, 1909.

(35 Stat., 1137.)

The importation of certain injurious animals and birds; permits for foreign wild animals and birds; cage birds, specimens for museums, etc.

SEC. 241. The importation into the United States, or any Territory or District thereof, of the mongoose, the so-called "flying foxes," or fruit bats, the English sparrow, the starling, and such other birds and animals as the Secretary of Agriculture may from time to time declare to be injurious to the interests of agriculture or horticulture, is hereby prohibited; and all such birds and animals shall, upon arrival at any port of the United States, be destroyed or returned at the expense of the owner. No person shall import into the United States or into any Territory or District thereof any foreign wild animal or bird, except under special permit from the Secretary of Agriculture: *Provided*, That nothing in this section shall restrict the importation of natural-history specimens for museums or scientific collections, or of certain cage birds, such as domesticated canaries, parrots, or such other birds as the Secretary of Agriculture may designate. The Secretary of the Treasury is hereby authorized to make regulations for carrying into effect the provisions of this section.

Interstate transportation of animals and birds illegally imported and game killed or shipped in violation of State laws; transportation of game in season; feathers of barnyard fowls.

SEC. 242. It shall be unlawful for any person to deliver to any common carrier for transportation, or for any common carrier to transport from any State, Territory, or District of the United States to any other State, Territory, or District thereof, any foreign animals or birds the importation of which is prohibited, or the dead bodies or parts thereof of any wild animals or birds, where such animals or birds have been killed or shipped in violation of the laws of the State, Territory, or District in which the same were killed, or from which they were shipped: *Provided*, That nothing herein shall prevent the transportation of any dead birds or animals killed during the season when the same may be lawfully captured, and the export of which is not prohibited by law in the State, Territory, or District in which the same are captured or killed: *Provided further*, That nothing herein shall prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowls.

Marking of packages containing bodies or plumage of game animals or game or other wild birds.

SEC. 243. All packages containing the dead bodies, or the plumage, or parts thereof, of game animals, or game or other wild birds, when shipped in interstate or foreign commerce, shall be plainly and clearly marked, so that the name and address of the shipper, and the nature of the contents, may be readily ascertained on an inspection of the outside of such package.

Penalty for violations of sections 241 to 244.

SEC. 244. For each evasion or violation of any provision of the three sections last preceding, the shipper shall be fined not more than $200; the consignee knowingly receiving such articles so shipped and transported in violation of said sections shall be fined not more than $200; and the carrier knowingly carrying or transporting the same in violation of said sections shall be fined not more than $200.

SECTIONS 1 AND 5—ACT OF MAY 25, 1900.

(31 Stat., 187–8.)

Preservation, distribution, introduction, and restoration of game birds and other wild birds; collection and publication of information as to propagation, uses, and preservation of such birds; regulation for carrying out purposes of act.

That the duties and powers of the Department of Agriculture are hereby enlarged so as to include the preservation, distribution, introduction, and restoration of game birds and other wild birds. The Secretary of Agriculture is hereby authorized to adopt such measures as may be necessary to carry out the purposes of this act and to purchase such game birds and other wild birds as may be required therefor, subject, however, to the laws of the various States and Territories. The object and purpose of this act is to aid in the restoration of such birds in those parts of the United States adapted thereto where the same have become scarce or extinct, and also to regulate the introduction of American or foreign birds or animals in localities where they have not heretofore existed.

The Secretary of Agriculture shall from time to time collect and publish useful information as to the propagation, uses, and preservation of such birds.

And the Secretary of Agriculture shall make and publish all needful rules and regulations for carrying out the purposes of this act, and shall expend for said purposes such sums as Congress may appropriate therefor.

Bodies of game animals and game and song birds subject to laws of State, etc., into which transported.

SEC. 5. That all dead bodies, or parts thereof, of any foreign game animals, or game or song birds, the importation of which is prohibited, or the dead bodies, or parts thereof, of any wild game animals, or game or song birds transported into any State or Territory, or remaining therein for use, consumption, sale, or storage therein, shall upon arrival in such State or Territory be subject to the operation and effect of the laws of such State or Territory enacted in the exercise of its police powers, to the same extent and in the same manner as though such animals or birds had been produced in such State or Territory, and shall not be exempt therefrom by reason of being introduced therein in original packages or otherwise. This act shall not prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowl.

TARIFF ACT, PROHIBITING IMPORTATION OF PLUMAGE.

ACT OF OCTOBER 3, 1913.

(38 Stat., 148.)

PAR. 347. Feathers and downs, on the skin or otherwise, crude or not dressed, colored, or otherwise advanced or manufactured in any manner, not specially provided for in this section, twenty per centum ad valorem; when dressed, colored, or otherwise advanced or manufactured in any manner, and not suitable for use as millinery ornaments, including quilts of down and manufactures of down, forty per centum ad valorem; artificial or ornamental feathers suitable for use as millinery ornaments, artificial and ornamental fruits, grains, leaves, flowers, and stems or parts thereof, of whatever material composed, not specially provided for in this section, sixty per centum ad valorem; boas, boutonnières, wreaths, and all articles not specially provided for in this section, composed wholly or in chief value of any of the feathers, flowers, leaves, or other material herein mentioned, sixty per centum ad valorem: *Provided*, That the importation of aigrettes, egret plumes or so-called osprey plumes, and the feathers, quills, heads, wings, tails, skins, or parts of skins, of wild birds, either raw or manufactured, and not for scientific or educational purposes, is hereby prohibited; but this provision shall not apply to the feathers or plumes of ostriches, or to the feathers or plumes of domestic fowls of any kind.

LAW PROTECTING BIRDS AND THEIR EGGS ON FEDERAL BIRD RESERVATIONS.

ACT OF MARCH 4, 1909.

(35 Stat., 1104.)

SEC. 84. Whoever shall hunt, trap, capture, willfully disturb, or kill any bird of any kind whatever, or take the eggs of any such bird, on any lands of the United States which have been set apart or reserved as breeding grounds for birds, by any law, proclamation, or Executive order, except under such rules and regulations as the Secretary of Agriculture may, from time to time, prescribe, shall be fined not more than $500, or imprisoned not more than six months, or both.

HUNTING ON NATIONAL FORESTS.

Regulation T-7a, effective October 1, 1918, of the Regulations of the Forest Service relative to national forests, provides as follows:

The going or being upon any land of the United States, or in or on the waters thereof, within a national forest with intent to hunt, catch, trap, willfully disturb or kill any kind of game animal, game or nongame bird, or fish, or to take the eggs of any such bird, in violation of the laws of the State in which such land or waters are situated, is hereby prohibited.

Regulation G-30 as amended October 1, 1918, authorizes all forest officers to enforce the above regulation and also to cooperate with State or Territorial officials in the enforcement of local laws for the protection of birds, fish, and game.

CONVENTION BETWEEN THE UNITED STATES AND GREAT BRITAIN FOR THE PROTECTION OF MIGRATORY BIRDS IN THE UNITED STATES AND CANADA.[1]

[39 Stat., 1702.]

BY THE PRESIDENT OF THE UNITED STATES OF AMERICA.

A PROCLAMATION.

Whereas a convention between the United States of America and the United Kingdom of Great Britain and Ireland for the protection of migratory birds in the United States and Canada was concluded and signed by their respective plenipotentiaries at Washington, on the sixteenth day of August, one thousand nine hundred and sixteen, the original of which convention is word for word as follows:

Whereas many species of birds in the course of their annual migrations traverse certain parts of the United States and the Dominion of Canada; and

Whereas many of these species are of great value as a source of food or in destroying insects which are injurious to forests and forage plants on the public domain, as well as to agricultural crops, in both the United States and Canada, but are nevertheless in danger of extermination through lack of adequate protection during the nesting season or while on their way to and from their breeding grounds;

The United States of America and His Majesty the King of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas, Emperor of India, being desirous of saving from indiscriminate slaughter and of insuring the preservation of such migratory birds as are either useful to man or are harmless, have resolved to adopt some uniform system of protection which shall effectively accomplish such objects and to the end of concluding a convention for this purpose have appointed as their respective Plenipotentiaries:

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[1] This treaty was signed on August 16, ratified by the Senate August 29, by the President September 1, and by Great Britain October 20; ratifications thereof were exchanged December 7, and it was proclaimed by the President December 8, 1916.

Canada, by an act of Parliament approved August 29, 1917, gave full effect to this convention, and promulgated regulations thereunder May 11, 1918.

The Constitution of the United States contains the following provision in regard to treaties:

"This Constitution, and the laws of the United States which shall be made in pursuance thereof; and all treaties made, or which shall be made, under the authority of the United States shall be the supreme law of the land; and he judges in every State shall be bound thereby, anything in the constitution or laws of any State to the contrary notwithstanding." (Art. VI, par. 2.)

The President of the United States of America, Robert Lansing, Secretary of State of the United States; and

His Britannic Majesty, the Right Honorable Sir Cecil Arthur Spring Rice, G. C. V. O., K. C. M. G., etc., His Majesty's Ambassador Extraordinary and Plenipotentiary at Washington;

Who, after having communicated to each other their respective full powers which were found to be in due and proper form, have agreed to and adopted the following articles:

ARTICLE I.

The High Contracting Powers declare that the migratory birds included in the terms of this Convention shall be as follows:

1. Migratory Game Birds:

(*a*) Anatidae or waterfowl, including brant, wild ducks, geese, and swans.

(*b*) Gruidae or cranes, including little brown, sandhill, and whooping cranes.

(*c*) Rallidae or rails, including coots, gallinules and sora and other rails.

(*d*) Limicolae or shorebirds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock and yellowlegs.

(*e*) Columbidae or pigeons, including doves and wild pigeons.

2. Migratory Insectivorous Birds: Bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, humming birds, kinglets, martins, meadowlarks, nighthawks or bull bats, nut-hatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, wax-wings, whippoorwills, woodpeckers and wrens, and all other perching birds which feed entirely or chiefly on insects.

3. Other Migratory Nongame Birds: Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

ARTICLE II.

The High Contracting Powers agree that, as an effective means of preserving migratory birds there shall be established the following close seasons during which no hunting shall be done except for scientific or propagating purposes under permits issued by proper authorities.

1. The close season on migratory game birds shall be between March 10 and September 1, except that the close season on the Limicolae or shorebirds in the Maritime Provinces of Canada and in those States of the United States bordering on the Atlantic Ocean which are situated wholly or in part north of Chesapeake Bay shall be between February 1 and August 15, and that Indians may take at any time scoters for food but not for sale. The season for hunting shall be further restricted to such period not exceeding three and one-half months as the High Contracting Powers may severally deem appropriate and define by law or regulation.

2. The close season on migratory insectivorous birds shall continue throughout the year.

3. The close season on other migratory nongame birds shall continue throughout the year, except that Eskimos and Indians may take at any season auks, auklets, guillemots, murres and puffins, and their eggs, for food and their skins for clothing, but the birds and eggs so taken shall not be sold or offered for sale.

ARTICLE III.

The High Contracting Powers agree that during the period of ten years next following the going into effect of this Convention, there shall be a continuous close season on the following migratory game birds, to wit:—

Band-tailed pigeons, little brown, sandhill and whooping cranes, swans, curlew and all shorebirds (except the black-breasted and golden plover, Wilson or jack snipe, woodcock, and the greater and lesser yellowlegs); provided that during such ten years the close seasons on cranes, swans and curlew in the Province of British Columbia shall be made by the proper authorities of that Province within the general dates and limitations elsewhere prescribed in this convention for the respective groups to which these birds belong.

ARTICLE IV.

The High Contracting Powers agree that special protection shall be given the wood duck and the eider duck either (1) by a close season extending over a period of at least five years, or (2) by the establishment of refuges, or (3) by such other regulations as may be deemed appropriate.

ARTICLE V.

The taking of nests or eggs of migratory game or insectivorous or nongame birds shall be prohibited, except for scientific or propagating purposes, under such laws or regulations as the High Contracting Powers may severally deem appropriate.

ARTICLE VI.

The High Contracting Powers agree that the shipment or export of migratory birds or their eggs from any State or Province, during the continuance of the close season in such State or Province, shall be prohibited except for scientific or propagating purposes, and the international traffic in any birds or eggs at such time captured, killed, taken, or shipped at any time contrary to the laws of the State or Province in which the same were captured, killed, taken, or shipped shall be likewise prohibited. Every package containing migratory birds or any parts thereof or any eggs of migratory birds transported, or offered for transportation from the United States into the Dominion of Canada or from the Dominion of Canada into the United States, shall have the name and address of the shipper and an accurate statement of the contents clearly marked on the outside of such package.

ARTICLE VII.

Permits to kill any of the above-named birds which, under extraordinary conditions, may become seriously injurious to the agricultural or other interests in any particular community, may be issued by the proper authorities of the High Contracting Powers under suitable regulations prescribed therefor by them respectively, but such permits shall lapse, or may be canceled, at any time when, in the opinion of said authorities, the particular exigency has passed, and no birds killed under this article shall be shipped, sold, or offered for sale.

ARTICLE VIII.

The High Contracting Powers agree themselves to take, or propose to their respective appropriate law-making bodies, the necessary measures for insuring the execution of the present Convention.

ARTICLE IX.

The present Convention shall be ratified by the President of the United States of America, by and with the advice and consent of the Senate thereof, and by His Britannic Majesty. The ratifications shall be exchanged at Washington as soon as possible and the Convention shall take effect on the date of the exchange of the ratifications. It shall remain in force for fifteen years, and in the event of neither of the High Contracting Powers having given notification, twelve months before the expiration of said period of fifteen years, of its intention of terminating its operation, the Convention shall continue to remain in force for one year and so on from year to year.

In faith whereof, the respective Plenipotentiaries have signed the present Convention in duplicate and have hereunto affixed their seals.

Done at Washington this sixteenth day of August, one thousand nine hundred and sixteen.

[SEAL.] ROBERT LANSING.
[SEAL.] CECIL SPRING RICE.

And whereas the said Convention has been duly ratified on both parts, and the ratifications of the two Governments were exchanged in the City of Washington, on the seventh day of December, one thousand nine hundred and sixteen;

Now, therefore, be it known that I, Woodrow Wilson, President of the United States of America, have caused the said Convention to be made public, to the end that the same and every article and clause thereof may be observed and fulfilled with good faith by the United States and the citizens thereof.

In testimony whereof, I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the City of Washington this eighth day of December in the year of our Lord one thousand nine hundred and sixteen, and of the Independence of the United States of America the one hundred and forty-first.

[SEAL.]

WOODROW WILSON.

By the President:
ROBERT LANSING,
Secretary of State.

MIGRATORY-BIRD TREATY ACT.

[Approved July 3, 1918. 40 Stat., 755.]

AN ACT To give effect to the convention between the United States and Great Britain for the protection of migratory birds concluded at Washington, August sixteenth, nineteen hundred and sixteen, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act shall be known by the short title of the "Migratory Bird Treaty Act."

Sec. 2. That unless and except as permitted by regulations made as hereinafter provided, it shall be unlawful to hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time or in any manner, any migratory bird, included in the terms of the convention between the United States and Great Britain for the protection of migratory birds concluded August sixteenth, nineteen hundred and sixteen, or any part, nest, or egg of any such bird.

Sec. 3. That subject to the provisions and in order to carry out the purposes of the convention, the Secretary of Agriculture is authorized and directed, from time to time, having due regard to the zones of temperature and to the distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds, to determine when, to what extent, if at all, and by what means, it is compatible with the terms of the convention to allow hunting, taking, capture, killing, possession, sale, purchase, shipment, transportation, carriage, or export of any such bird, or any part, nest, or egg thereof, and to adopt suitable regulations permitting and governing the same, in accordance with such determinations, which regulations shall become effective when approved by the President.

Sec. 4. That it shall be unlawful to ship, transport, or carry, by any means whatever, from one State, Territory, or District to or through another State, Territory, or District, or to or through a foreign country, any bird, or any part, nest, or egg thereof, captured, killed, taken, shipped, transported, or carried at any time contrary to the laws of the State, Territory, or District in which it was captured, killed, or taken, or from which it was shipped, transported, or carried. It shall be unlawful to import any bird, or any part, nest, or egg thereof, captured, killed, taken, shipped, transported, or carried contrary to the laws of any Province of the Dominion of Canada in which the same was captured, killed, or taken, or from which it was shipped, transported, or carried.

Sec. 5. That any employee of the Department of Agriculture authorized by the Secretary of Agriculture to enforce the provisions of this act shall have power, without warrant, to arrest any person committing a violation of this act in his presence or view and to take such person immediately for examination or trial before an officer or court of competent jurisdiction; shall have power to execute any warrant or other process issued by an officer or court of competent jurisdiction for the enforcement of the provisions of this act; and shall have authority, with a search warrant, to search any place. The several judges of the courts established under the laws of the United States, and United States commissioners may, within their respective jurisdictions, upon proper oath or affirmation showing probable cause, issue warrants in all such cases. All birds, or parts, nests, or eggs thereof, captured, killed, taken, shipped, transported, carried, or possessed contrary to the provisions of this act or of any regulations made pursuant thereto shall, when found, be seized by any such employee, or by any marshal or deputy marshal, and upon conviction of the offender or upon judgment of a court of the United States that the same were captured, killed, taken, shipped, transported, carried, or possessed contrary to the provisions of this act or of any regulation made pursuant thereto, shall be forfeited to the United States and disposed of as directed by the court having jurisdiction.

SEC. 6. That any person, association, partnership, or corporation who shall violate any of the provisions of said convention or of this act, or who shall violate or fail to comply with any regulation made pursuant to this act, shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined not more than $500 or be imprisoned not more than six months, or both.

SEC. 7. That nothing in this act shall be construed to prevent the several States and Territories from making or enforcing laws or regulations not inconsistent with the provisions of said convention or of this act, or from making or enforcing laws or regulations which shall give further protection to migratory birds, their nests, and eggs, if such laws or regulations do not extend the open seasons for such birds beyond the dates approved by the President in accordance with section three of this act.

SEC. 8. That until the adoption and approval, pursuant to section three of this act, of regulations dealing with migratory birds and their nests and eggs, such migratory birds and their nests and eggs as are intended and used exclusively for scientific or propagating purposes may be taken, captured, killed, possessed, sold, purchased, shipped, and transported for such scientific or propagating purposes if and to the extent not in conflict with the laws of the State, Territory, or District in which they are taken, captured, killed, possessed, sold, or purchased, or in or from which they are shipped or transported if the packages containing the dead bodies or the nests or eggs of such birds when shipped and transported shall be marked on the outside thereof so as accurately and clearly to show the name and address of the shipper and the contents of the package.

SEC. 9. That the unexpended balances of any sums appropriated by the agricultural appropriation acts for the fiscal years nineteen hundred and seventeen and nineteen hundred and eighteen, for enforcing the provisions of the act approved March fourth, nineteen hundred and thirteen, relating to the protection of migratory game and insectivorous birds, are hereby reappropriated and made available until expended for the expenses of carrying into effect the provisions of this act and regulations made pursuant thereto, including the payment of such rent, and the employment of such persons and means, as the Secretary of Agriculture may deem necessary, in the District of Columbia and elsewhere, cooperation with local authorities in the protection of migratory birds, and necessary investigations connected therewith: *Provided*, That no person who is subject to the draft for service in the Army or Navy shall be exempted or excused from such service by reason of his employment under this act.

SEC. 10. That if any clause, sentence, paragraph, or part of this act shall, for any reason, be adjudged by any court of competent jurisdiction to be invalid, such judgment shall not affect, impair, or invalidate the remainder thereof, but shall be confined in its operation to the clause, sentence, paragraph, or part thereof directly involved in the controversy in which such judgment shall have been rendered.

SEC. 11. That all acts or parts of acts inconsistent with the provisions of this act are hereby repealed.

SEC. 12. Nothing in this act shall be construed to prevent the breeding of migratory game birds on farms and preserves and the sale of birds so bred under proper regulation for the purpose of increasing the food supply.

SEC. 13. That this act shall become effective immediately upon its passage and approval.

MIGRATORY-BIRD TREATY-ACT REGULATIONS.

[As approved and promulgated by the President, July 31, 1918, and amended October 25, 1918, and July 28, 1919.]

REGULATION 1.—DEFINITIONS OF MIGRATORY BIRDS.

Migratory birds, included in the terms of the convention between the United States and Great Britain for the protection of migratory birds, concluded August 16, 1916, are as follows:

1. *Migratory game birds:*

(*a*) Anatidae, or waterfowl, including brant, wild ducks, geese, and swans.

(*b*) Gruidae, or cranes, including little brown, sandhill, and whooping cranes.

(*c*) Rallidae, or rails, including coot, gallinules, and sora and other rails.

(*d*) Limicolae, or shorebirds, including avocets, curlews, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs.

(*e*) Columbidae, or pigeons, including doves and wild pigeons.

2. *Migratory insectivorous birds:* Bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, hummingbirds, kinglets, martins, meadowlarks, nighthawks or bull-bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whip-poor-wills, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects.

3. *Other migratory nongame birds:* Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

REGULATION 2.—DEFINITIONS OF TERMS.

For the purposes of these regulations the following terms shall be construed, respectively, to mean—

Secretary.—The Secretary of Agriculture of the United States.

Person.—The plural or the singular, as the case demands, including individuals, associations, partnerships, and corporations, unless the context otherwise requires.

Take.—The pursuit, hunting, capture, or killing of migratory birds in the manner and by the means specifically permitted.

Open season.—The time during which migratory birds may be taken.

Transport.—Shipping, transporting, carrying, exporting, receiving or delivering for shipment, transportation, carriage, or export.

REGULATION 3.—MEANS BY WHICH MIGRATORY GAME BIRDS MAY BE TAKEN.

The migratory game birds specified in Regulation 4 hereof may be taken during the open season with a gun only, not larger than number 10 gauge, fired from the shoulder, except as specifically permitted by Regulations 7, 8, 9, and 10 hereof; they may be taken during the open season from the land and water, from a blind or floating device (other than an airplane, powerboat, sailboat, any boat under sail, or any floating device towed by powerboat or sailboat), with the aid of a dog, and the use of decoys.

[As amended July 28, 1919.]

REGULATION 4.—OPEN SEASONS ON AND POSSESSION OF CERTAIN MIGRATORY GAME BIRDS.

For the purpose of this regulation, each period of time herein prescribed as an open season shall be construed to include the first and last days thereof.

Waterfowl (except wood duck, eider ducks, and swans), rails, coot, gallinules, black-bellied and golden plovers, greater and lesser yellowlegs, woodcock, Wilson snipe or jacksnipe, and mourning and white-winged doves may be taken each day from half an hour before sunrise to sunset during the open seasons prescribed therefor in this regulation, by the means and in the numbers permitted by Regulations 3 and 5 hereof, respectively, and when so taken, each species may be possessed any day during the respective open seasons herein prescribed therefor and for an additional period of 10 days next succeeding said open season.

Waterfowl (except wood duck, eider ducks, and swans), coot, gallinules, and Wilson snipe or jacksnipe.—The open seasons for waterfowl (except wood duck, eider ducks, and swans), coot, gallinules, and Wilson snipe or jacksnipe shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, New York (except Long Island), Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, Idaho, Nevada, and that portion of Oregon and Washington lying east of the summit of the Cascade Mountains the open season shall be from September 16 to December 31;

In Rhode Island, Connecticut, Utah, and that portion of Oregon and Washington lying west of the summit of the Cascade Mountains the open season shall be from October 1 to January 15;

In that portion of New York known as Long Island, and in New Jersey, Delaware, Oklahoma, Texas, New Mexico, Arizona, and California the open season shall be from October 16 to January 31;

In Maryland, the District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, and Louisiana the open season shall be from November 1 to January 31; and

In Alaska the open season shall be from September 1 to December 15.

Rails (except coot and gallinules).—The open season for sora and other rails (except coot and gallinules) shall be from September 1 to November 30, except as follows:

In Louisiana the open season shall be from November 1 to January 31.

Black-bellied and golden plovers and greater and lesser yellowlegs.—The open seasons for black-bellied and golden plovers and greater and lesser yellowlegs shall be as follows:

In Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, and Virginia the open season shall be from August 16 to November 30;

In the District of Columbia, North Carolina, South Carolina, Tennessee, Arkansas, Oklahoma, Texas, New Mexico, Arizona, California, and Alaska the open season shall be from September 1 to December 15;

In Vermont, Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, Idaho, Nevada, and that portion of Oregon and Washington lying east of the summit of the Cascade Mountains the open season shall be from September 16 to December 31;

In Utah and in that portion of Oregon and Washington lying west of the summit of the Cascade Mountains the open season shall be from October 1 to January 15; and

In Georgia, Florida, Alabama, Mississippi, and Louisiana the open season shall be from November 1 to January 31.

Woodcock.—The open seasons for woodcock shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, and Kansas the open season shall be from October 1 to November 30; and

In Delaware, Maryland, the District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, Texas, and Oklahoma the open season shall be from November 1 to December 31.

Doves.—The open seasons for mourning doves shall be as follows:

In Delaware, Maryland, Virginia, Tennessee, Kentucky, Ohio, Indiana, Illinois, Nebraska, Kansas, Missouri, Arkansas, Oklahoma, Texas, New Mexico, Colorado, Utah, Arizona, California, Nevada, Idaho, and Oregon the open season shall be from September 1 to December 15;

In North Carolina, Mississippi, and Louisiana the open season shall be from September 16 to December 31; and

In South Carolina, Georgia, Florida, and Alabama the open season shall be from October 16 to January 31.

[As amended October 25, 1918, and July 28, 1919.]

REGULATION 5.—BAG LIMITS ON CERTAIN MIGRATORY GAME BIRDS.

A person may take in any one day during the open seasons prescribed therefor in Regulation 4 not to exceed the following numbers of migratory game birds:

Ducks (except wood duck and eider ducks).—Twenty-five in the aggregate of all kinds.

Geese.—Eight in the aggregate of all kinds.

Brant.—Eight.

Rails, coot, and gallinules (except sora).—Twenty-five in the aggregate of all kinds.

Sora.—Fifty.

Black-bellied and golden plovers and greater and lesser yellowlegs.—Fifteen in the aggregate of all kinds.

Wilson snipe, or jacksnipe.—Twenty-five.

Woodcock.—Six.

Doves (mourning).—Twenty-five.

[As amended October 25, 1918, and July 28, 1919.]

REGULATION 6.—SHIPMENT AND TRANSPORTATION OF CERTAIN MIGRATORY GAME BIRDS.

Waterfowl (except wood duck, eider ducks, and swans), rails, coot, gallinules, black-bellied and golden plovers, greater and lesser yellowlegs, woodcock, Wilson snipe or jacksnipe, and mourning and white-winged doves and parts thereof legally taken may be transported in or out of the State where taken during the respective open seasons in that State, and may be imported from Canada during the open season in the Province where taken, in any manner, but not more than the number thereof that may be taken in two days by one person under these regulations shall be transported by one person in one calendar week out of the State where taken; any such migratory game birds or parts thereof in transit during the open season may continue in transit such additional time immediately succeeding such open season, not to exceed five days, necessary to deliver the same to their destination; and any package in which migratory game birds or parts thereof are transported shall have the name and address of the shipper and of the consignee and an accurate statement of the numbers and kinds of birds contained therein clearly and conspicuously marked on the outside thereof; but no such birds shall be transported from any State, Territory, or District to or through another State, Territory, or District, or to or through a Province of the Dominion of Canada contrary to the laws of the State, Territory, or District, or Province of the Dominion of Canada in which they were taken or from which they are transported; nor shall any such birds be transported into any State, Territory, or District from another State, Territory, or District, or from any State, Territory, or District into any Province of the Dominion of Canada at a time when such State, Territory, or District, or Province of the Dominion of Canada prohibits the possession or transportation thereof.

[As amended October 25, 1918.]

REGULATION 7.—TAKING OF CERTAIN MIGRATORY NONGAME BIRDS BY ESKIMOS AND INDIANS IN ALASKA.

In Alaska Eskimos and Indians may take for the use of themselves and their immediate families, in any manner and at any time, and possess and transport auks, auklets, guillemots, murres, and puffins and their eggs for food, and their skins for clothing.

REGULATION 8.—PERMITS TO PROPAGATE AND SELL MIGRATORY WATERFOWL.

1. A person may take in any manner and at any time migratory waterfowl and their eggs for propagating purposes when authorized by a permit issued by the Secretary. Waterfowl and their eggs so taken may be possessed by the permittee and may be sold and transported by him for propagating purposes to any person holding a permit issued by the Secretary in accordance with the provisions of this regulation.

2. A person authorized by a permit issued by the Secretary may possess, buy, sell, and transport migratory waterfowl and their increase and eggs in any manner and at any time for propagating purposes; and migratory waterfowl, except the birds taken under paragraph 1 of this regulation, so possessed may be killed by him at any time, in any manner, except that they may be killed by shooting only during the open season for waterfowl in the State where taken, and the unplucked carcasses and the plucked carcasses, with heads and feet attached thereto, of the birds so killed may be sold and transported by him in any manner and at any time to any person for actual consumption, or to the keeper of a hotel, restaurant, or boarding house, retail dealer in meat or game, or a club, for sale or service to their patrons, who may possess such carcasses for actual consumption without a permit, but after midnight of March 31, 1919, no migratory waterfowl killed by shooting shall be bought or sold unless each bird before attaining the age of four weeks shall have had removed from the web of one foot a portion thereof in the form of a "V" large enough

to make a permanent well-defined mark which shall be sufficient to identify them as birds raised in domestication under a permit.

3. Any package in which such waterfowl or parts thereof or their eggs are transported shall have plainly and conspicuously marked on the outside thereof the name and address of the permittee, the number of his permit, the name and address of the consignee, and an accurate statement of the number and kinds of birds or eggs contained therein.

4. Applications for permits must be addressed to the Secretary of Agriculture, Washington, D. C., and must contain the following information: Name and address of applicant; place where the business is to be carried on; number of acres of land used in the business and whether owned or leased by the applicant; number of each species of waterfowl in possession of applicant; names of species and number of birds or eggs of each species if permission is asked to take waterfowl or their eggs; and the particular locality where it is desired to take such waterfowl or eggs.

5. A person granted a permit under this regulation shall keep books and records which shall correctly set forth the total number of each species of waterfowl and their eggs possessed on the date of application for the permit and on the first day of January next following; also for the calendar year for which permit was issued the total number of each species reared and killed, number of each species and their eggs sold and transported, manner in which such waterfowl and eggs were transported, name and address of each person from or to whom waterfowl and eggs were purchased or sold, together with number and species and whether sold alive or dead; and the date of each transaction. A written report correctly setting forth this information shall be furnished the Secretary during the month of January next following the issuance of the permit.

6. A permittee shall at all reasonable hours allow any authorized employee of the United States Department of Agriculture to enter and inspect the premises where operations are being carried on under this regulation and to inspect the books and records of such permittee relating thereto.

7. Permits issued under this regulation shall be valid only during the calendar year of issue, shall not be transferable, and may be revoked by the Secretary, if the permittee violates any of the provisions of the Migratory Bird Treaty Act or of the regulations thereunder.

8. A person engaged in the propagation of migratory waterfowl on the date on which these regulations become effective will be allowed until September 30, 1918, to apply for the permit required by this regulation, but he shall not take any migratory waterfowl without a permit.

[As amended October 25, 1918.]

REGULATION 9.—PERMITS TO COLLECT MIGRATORY BIRDS FOR SCIENTIFIC PURPOSES.

A person may take in any manner and at any time migratory birds and their nests and eggs for scientific purposes when authorized by a permit issued by the Secretary, which permit shall be carried on his person when he is collecting specimens thereunder and shall be exhibited to any person requesting to see the same.

Application for a permit must be addressed to the Secretary of Agriculture, Washington, D. C., and must contain the following information: Name and address of applicant and name of State, Territory, or District in which specimens are proposed to be taken and the purpose for which they are intended. Each application shall be accompanied by certificates from two well-known ornithologists that the applicant is a fit person to be intrusted with a permit.

The permit will authorize the holder thereof to possess, buy, sell, and transport in any manner and at any time migratory birds, parts thereof, and their nests and eggs for scientific purposes. Public museums, zoological parks and societies, and public scientific and educational institutions may possess, buy, sell, and transport in any manner and at any time migratory birds and parts thereof, and their nests and eggs for scientific purposes without a permit, but no specimens shall be taken without a permit. The plumage and skins of migratory game birds legally taken may be possessed and transported by a person without a permit.

A taxidermist when authorized by a permit issued by the Secretary may possess, buy, sell, and transport in any manner and at any time migratory birds and parts thereof legally taken.

Permits shall be valid only during the calendar year of issue, shall not be transferable, and shall be revocable in the discretion of the Secretary. A person holding a permit shall report to the Secretary on or before January 10 following its expiration the number of skins, nests, or eggs of each species collected, bought, sold, or transported.

Every package in which migratory birds or their nests or eggs are transported shall have clearly and conspicuously marked on the outside thereof the name and address of the sender, the number of the permit in every case when a permit is required, the name and address of the consignee, a statement that it contains specimens of birds, their nests, or eggs for scientific purposes, and, whenever such a package is transported or offered for transportation from the Dominion of Canada into the United States or from the United States into the Dominion of Canada, an accurate statement of the contents.

[As amended October 25, 1918.]

REGULATION 10.—PERMITS TO KILL MIGRATORY BIRDS INJURIOUS TO PROPERTY.

When information is furnished the Secretary that any species of migratory bird has become, under extraordinary conditions, seriously injurious to agriculture or other interests in any particular community, an investigation will be made to determine the nature and extent of the injury, whether the birds alleged to be doing the damage should be killed, and, if so, during what times and by what means. Upon his determination an appropriate order will be made.

REGULATION 11.—SALE OF MIGRATORY GAME BIRDS LAWFULLY HELD IN COLD STORAGE JULY 31, 1918.

A person authorized by a permit issued by the Secretary may possess and may sell and transport until midnight of March 31, 1919, the carcasses of migratory game birds lawfully killed and by him lawfully held in cold storage on July 31, 1918, to any person for actual consumption, or to the keeper of a hotel, restaurant, or boarding house, retail dealer in meat or game, or a club, for sale or service to their patrons, who may possess such carcasses for actual consumption without a permit until midnight of April 5, 1919.

[Added by proclamation of October 25, 1918.]

REGULATION 12.—STATE LAWS FOR THE PROTECTION OF MIGRATORY BIRDS.

Nothing in these regulations shall be construed to permit the taking, possession, sale, purchase, or transportation of migratory birds, their nests, and eggs contrary to the laws and regulations of any State, Territory, or District made for the purpose of giving further protection to migratory birds, their nests, and eggs when such laws and regulations are not inconsistent with the convention between the United States and Great Britain for the protection of migratory birds concluded August 16, 1916, or the migratory bird treaty act and do not extend the open seasons for such birds beyond the dates prescribed by these regulations.

[Added by proclamation of October 25, 1918.]

ORDER

PERMITTING THE KILLING OF BOBOLINKS, COMMONLY KNOWN AS REEDBIRDS OR RICE BIRDS, WHICH HAVE BECOME SERIOUSLY INJURIOUS TO AGRICULTURAL INTERESTS.

[Issued January 17, 1919.]

Information having been furnished the Secretary of Agriculture that bobolinks, commonly known as reedbirds or rice birds, have become seriously injurious to the rice crops in North Carolina, South Carolina, Georgia, and Florida, and an investigation having been duly and regularly made pursuant to law, and it having been determined by the Secretary of Agriculture that said birds have become, under extraordinary conditions, seriously injurious to the rice crops in said States and that the injuries so inflicted by them can not adequately be controlled in the communities immediately affected, and that they should therefore be killed in the manner, during the seasons, and in the States and District hereinafter provided,

NOW, THEREFORE, I, D. F. Houston, Secretary of Agriculture, pursuant to authority in me vested by the Migratory-Bird Treaty Act of July 3, 1918, and in conformity with Regulation 10 of the Migratory-Bird Treaty-Act Regulations approved and proclaimed July 31, 1918, do order that until further notice persons may kill by shooting, bobolinks, commonly known as reedbirds or rice birds, from half an hour before sunrise to sunset, from September 1 to October 30, inclusive, in the States of New Jersey, Pennsylvania, Delaware, and Maryland and the District of Columbia, and from August 16 to November 15, inclusive, in the States of Virginia, North Carolina, South Carolina, Georgia, and Florida, but the birds so killed shall not be sold, offered for sale, or shipped for purposes of sale, or be wantonly wasted or destroyed, but they may be used for food purposes by the persons killing them, and they may be transported to hospitals and charitable institutions for use as food.

D. F. Houston,
Secretary of Agriculture.

CANADIAN REGULATIONS UNDER MIGRATORY-BIRDS CONVENTION ACT.

1. In these regulations, unless the context otherwise requires:

(a) "Migratory game birds" means the following:

Anatidæ or waterfowl, including brant, wild ducks, geese, and swans;
Gruidæ or cranes, including little brown[,] sandhill and whooping cranes;
Rallidæ or rails, including coots, gallinules, and sora and other rails;
Limicolæ or shorebirds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs;
Columbidæ or pigeons, including doves and wild pigeons.

(*b*) "Migratory insectivorous birds" means the following:

Bobolinks, catbirds, chickadees, cukoos, flickers, fly-catchers, grosbeaks, humming birds, kinglets, martins, meadowlarks, nighthawks or bull bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whippoorwill, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects.

(*c*) "Migratory nongame birds" means the following:

Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

2. No person shall kill, capture, injure, take, molest, sell, or offer for sale any migratory game birds during the following periods:

Ducks, geese, brant, or rails:

In Prince Edward Island, New Brunswick, Quebec, Ontario, Alberta, British Columbia (northern district), Northwest Territories, and Yukon Territory, December 15 to August 31, both days inclusive.

In Manitoba, December 1 to September 14, both days inclusive.

In Nova Scotia, Saskatchewan, and British Columbia (southeastern district), January 1 to September 14, both days inclusive.

In British Columbia (southwestern district), January 15 to September 30, both days inclusive.

Shore birds or waders, including only the following:

Woodcock, Wilson or jack snipe, blackbreasted and golden plover, and the greater and lesser yellowlegs.

In Prince Edward Island, Nova Scotia, New Brunswick, and in the counties of Saguenay, Rimouski, Gaspe, and Bonaventure in Quebec:

December 1 to August 14, both days inclusive, except that on woodcock and Wilson or jack snipe the closed season in Prince Edward Island and New Brunswick shall be from December 1 to September 14, and in Nova Scotia from December 15 to August 31, both days inclusive.

In Quebec, other than the aforementioned maritime counties, Ontario, Alberta, British Columbia (northern district), Northwest Territories, and Yukon Territory, December 15 to August 31, both days inclusive, except that on woodcock and Wilson or jack snipe the close season in Ontario shall be from November 15 to October 14, both days inclusive.

In Manitoba: December 1 to September 14, both days inclusive.

In Saskatchewan and British Columbia (southeastern district): January 1 to September 14, both days inclusive.

In British Columbia (southwestern district): January 15 to September 30, both days inclusive.

Provided, however, That—

Indians and Eskimos may take scoters or "Siwash ducks" for food at any time of the year, but scoters so taken shall not be sold.

In this or any other regulation the southern limit of the northern district of British Columbia shall be, west to east, a line running by way of the middle of Dean Channel, Dean River, Entiako River, Nechako River, and the Fraser River from Fort George to Yellowhead Pass; and the line of division between the southeastern and the southwestern districts of British Columbia shall be the summit of the Cascade Range, as defined by the British Columbia interpretation act, Revised Statutes, 1911.

3. The killing, capturing, taking, injuring, or molesting of migratory insectivorous birds, their eggs, or nests, is prohibited throughout the year, except as hereinafter provided.

4. The killing, taking, injuring, capturing or molesting of migratory nongame birds or their eggs or nests, except as herein or hereinafter provided, is

prohibited throughout the year; *Provided, however,* That Indians and Eskimos may take at any season auks, auklets, guillemots, murres, and puffins and their eggs for human food and their skins for clothing, but birds and eggs taken in virtue of this exemption shall not be sold or offered for sale or otherwise traded.

5. A close season shall continue until the 1st day of January, 1928, on the following migratory game birds: Band-tailed pigeons, little brown, sandhill, and whooping cranes, swans, curlew, and all shore birds (except the black-breasted and golden plover, Wilson or jack snipe, woodcock, and the greater and lesser yellowlegs). In the Province of British Columbia during such period the close season on cranes, swans, and curlew shall be made by the proper authorities of that Province within the general dates and limitations elsewhere prescribed in these regulations for the respective groups to which these birds belong or greater restrictions on the hunting of these birds shall be made should the aforementioned authorities deem such further restriction desirable, as provided by Article III of the convention between His Majesty and the United States of America, scheduled to chapter 18, 7-8 George V.

6. A close season shall continue until the 1st day of January, 1923, on the wood duck and eider duck, except that in the Province of British Columbia the wood duck shall be protected by such special means or regulations as the proper authorities of that Province may deem appropriate, as provided by the convention referred to in clause 5.

7. The taking of the nests or eggs of migratory game, migratory insectivorous or migratory nongame birds is prohibited except as otherwise provided in the regulations.

8. Migratory game, migratory insectivorous or migratory nongame birds or parts thereof or their eggs or nests may be taken, shipped, transported or possessed for scientific or propagating purposes, but only on the issue of a permit by the minister or by any person duly authorized by him. Such a permit shall terminate at the end of the calendar year in which it shall have been issued; it shall not be transferable, and shall be revocable at the discretion of the minister.

Such permits may, upon application, be granted to recognized museums or scientific societies, and to any person furnishing written testimonials from two well-known ornithologists.

Applications for permits for propagating purposes shall be accompanied by a statement giving—

(1) The species of birds or eggs that it is desired to take.
(2) The number,
(3) The place at which the birds or eggs are to be taken.

Any package in which such migratory game, migratory insectivorous, or migratory nongame birds or parts thereof or their eggs or nests are shipped or transported for scientific or propagating purposes shall be clearly marked on the outside with the number of the permit, the name and address of the shipper and an accurate statement of the contents.

No transportation company shall accept for transportation any package containing eggs, nests, or parts of migratory game, migratory insectivorous or migratory nongame birds unless such package shall be marked as hereinbefore required, and shipment of the same through the mails is prohibited, unless marked as aforesaid.

9. The shipment or export of migratory game, migratory insectivorous, or migratory nongame birds or their eggs from any Province during the close season in such Provinces is prohibited except for scientific or propagating pur-

poses and traffic between Canada and the United States in any such birds, or their eggs, captured, killed, taken, or shipped at any time contrary to the laws of the Province or State in which the same are captured, killed, taken or shipped, is likewise prohibited.

10. No person shall ship or offer for shipment from Canada to the United States any package containing migratory game, migratory insectivorous or migratory nongame birds or any parts thereof or their eggs unless such package shall have the name and address of the shipper and an accurate statement of the contents clearly marked on the outside of such package.

No transportation company shall accept for transportation to the United States, any packages of migratory game, migratory insectivorous or migratory nongame birds or any parts thereof or their eggs unless such packages bear the name and address of the shipper and an accurate statement of the contents, and shipment of the same through the mails is prohibited unless marked as aforesaid.

11. If any of the migratory game, migratory insectivorous, or migratory nongame birds should, under extraordinary conditions, become seriously injurious to agricultural, fishing, or other interests in any particular locality the minister may issue permits to kill such birds so long as they shall continue to be injurious. Applications for such permits shall include a full statement describing:

(1) The species and an estimate of the number of birds committing the damage.

(2) The nature and extent of the damage.

(3) The extent of the agricultural or other interests threatened or involved.

Such permits shall be revocable at the discretion of the minister. On the expiration of the permit the person to whom it is issued shall furnish to the minister a written report showing the number of birds killed, the dates upon which they were killed and the disposition made of the dead birds.

No birds killed under such permits shall be shipped, sold, or offered for sale.

12. No person or organization shall introduce for the purpose of sport or acclimatization any species of migratory birds without the consent of the minister in writing.

CANADIAN TARIFF ACT PROHIBITING IMPORTATION OF PLUMAGE.

The importation of bird plumage into Canada for millinery purposes is prohibited by tariff item 1212 under schedule C (prohibited goods) to the customs tariff, section 5, by the enactment of the Canadian customs tariff act of 1914. Item 1212 prohibits the entry of the following:

1212. Aigrettes, egret plumes, or so-called osprey plumes, and the feathers, quills, heads, wings, tails, skins, or parts of skins of wild birds either raw or manufactured; but this provision shall not come into effect until January 1, 1915, and shall not apply to—

(*a*) The feathers or plumes of ostriches;

(*b*) The plumage of the English pheasant and the Indian peacock;

(*c*) The plumage of wild birds ordinarily used as articles of diet;

(*d*) The plumage of birds imported alive, nor to

(*e*) Specimens imported under regulations of the minister of customs for any natural-history or other museum or for educational purposes.

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FARMERS' BULLETIN 1078
UNITED STATES DEPARTMENT OF AGRICULTURE

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Harvesting and Storing Ice on the Farm

WHERE a stream of water or pond is available in the northern section of the United States, natural ice can be harvested and stored at low cost.

Care should be used to insure that the source of the ice supply is free from pollution and contamination.

Where very cold weather prevails in the winter and ponds and streams are not available, cans or paper sacks may be used for freezing cakes of ice.

The space used for storing ice should accommodate about 50 per cent more than is actually needed, which allows for a heavy shrinkage and for general household purposes.

A cubic foot of ice weighs about 57 pounds. About 45 cubic feet of space should be allowed ordinarily for storing a ton of ice.

Under ordinary circumstances from about ½ to 1 ton of ice per cow is needed annually for cooling cream and from 1½ to 2 tons for cooling milk on a dairy farm.

Contribution from the Bureau of Animal Industry
JOHN R. MOHLER, Chief
Washington, D. C. January, 1920

HARVESTING AND STORING ICE ON THE FARM.[1]

JOHN T. BOWEN, *Dairy Division.*

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THE SOURCES OF ICE.

WATER for the ice supply should be free from contamination or pollution. Ponds and sluggish streams usually have grass and weeds growing in them so that ice harvested from them may contain decayed vegetable matter, which is always an objectionable condition and may be injurious to health. These should, therefore, be thoroughly cleared of such growth before cold weather. Green spawn and algæ may be destroyed by the use of copper sulphate (blue vitriol). The crystals can be placed in a cloth bag which is hung on the end of a pole and trailed through the water until all the crystals are dissolved. One or two treatments during the summer season at the rate of 1 pound of copper sulphate to 13,000 cubic feet of water will be sufficient to keep down such growths.

Careful investigation should be made to determine whether the source of ice supply is pure and free from contamination or pollution. Streams or lakes are often polluted by sewage or other impurities which it is impossible to eliminate. A pure ice supply is especially important when the ice is to be used directly in beverages or other foods.

Throughout a considerable area of the United States natural ice is formed during the winter months in sufficient quantity to warrant

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NOTE.—Acknowledgment is made to the Division of Rural Engineering, Bureau of Public Roads, for collaboration and assistance in the preparation and revision of the text matter and drawings of this bulletin.

[1] A revision of Farmers' Bulletin 623, "Ice Houses and the Use of Ice on the Dairy Farm."

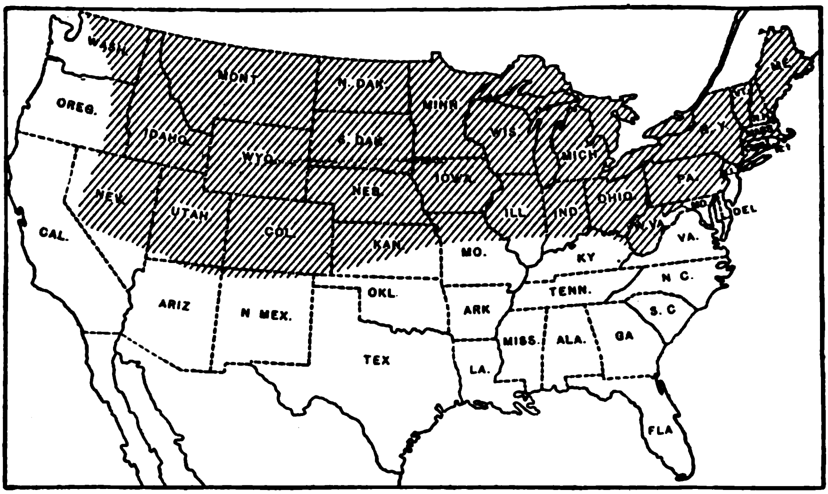

FIG. 1.—Map of the United States, showing region in which natural ice may be harvested in normal winters.

harvesting and storing (fig. 1). In many sections of this area are lakes, ponds, and streams from which ice can be harvested, while in others it is necessary to create artificially a suitable body of water for producing ice. This may be done either by excavating and diverting a stream into an excavation or by constructing dams across low areas. When it is necessary to construct artificial ponds the surface area is usually limited and several cuttings are ordinarily necessary to obtain the quantity of ice needed. (Figs. 2 and 3.)

FIG. 2.—Artificial pond in yard.

When cold weather prevails for several weeks at a time and the supply of pure water is limited, a method of freezing ice in metal cans or special paper bags may be used. The cans may be made in any convenient size by a local tinsmith and should be of galvanized iron reinforced at top and bottom with iron strips. The bottom is made smaller than the top, to make the removal of the ice easier. The cans are placed near the water supply, filled with water, and left exposed to the weather. A shell of ice soon freezes around the inner surface, and when the shell is from 1½ to 2 inches thick, hot water is poured over the outside of the can and the shell removed. A hole is broken through at the top of the shell and most of the water inside is then poured out. As the freezing progresses water is poured into the shell a little at a time until a solid block of ice is produced. By this method only a few cans are required, which keeps the cost low.

FIG. 3.—Natural pond.

About the same method is employed when special paper bags are used, although they do not last so long as the cans. The advantage of the bags over the metal cans is mainly in cheapness, for they are not so convenient to handle.

Another method that can be used in very cold sections of the United States is to run water into the ice house and let a layer freeze. This is done by first constructing a dam of snow around the floor of the house 10 or 12 inches from the walls in order to allow sawdust insulation next to the walls. The interior of the house is then flooded with a few inches of water, which soon freezes, the procedure being repeated until the house is filled with ice. It is then covered with sawdust and closed up until ice is needed. A great disadvantage of this method is that in order to remove ice it must be cut or chopped out with an ax, which results in uneven and irregular pieces and considerable waste of ice.

Floe ice is another source of natural ice. It is obtained in the spring when large chunks or pieces of ice float down from the headwaters of streams and rivers. This ice is always broken up into irregular pieces and is not so easily handled and packed as that which is cut in regular shape.

HARVESTING ICE.

SIZE OF ICE FIELD.

When the field is of sufficient size to fill the ice house at a single cutting, the thickness and quality of the ice is more nearly uniform and preparation for cutting and harvesting need be made but once. In many instances, however, the small size of the pond or stream makes it necessary to wait for a second crop in order to fill the ice house. The average dairy requires only a moderate quantity of ice, so that even a small harvesting surface usually is large enough, especially if ice is cut a second time. The number of square feet of surface required per ton with ice of different thicknesses is shown in Table 1.

TABLE 1.—*Number of cakes of various thicknesses required per ton of ice (size of cake, 22 by 22 inches).*

Thickness of ice.	Number of cakes required per ton.	Cutting space required per ton.	Thickness of ice.	Number of cakes required per ton.	Cutting space required per ton.
Inches.		*Square feet.*	*Inches.*		*Square feet.*
4	31.3	105.4	14	8.9	30.1
6	20.9	70.2	16	7.8	26.3
8	15.6	52.6	18	6.9	23.4
10	12.5	42.1	20	6.3	21.1
12	10.4	35.1	22	5.7	19.1

REMOVING SNOW FROM SURFACE.

Where it is not advisable to wet the surface of the ice field and thus hasten the freezing, the snow should be scraped from the surface of the ice, since snow acts as insulation and retards freezing. If the ice is thick enough to bear the weight of a horse the snow may be removed easily with a scraper, such as is shown in figures 4 and 5. On small ponds the snow may be scraped on to the shore, but on large fields, especially if the snow is deep, it is impracticable to scrape it entirely off the fields. It becomes necessary therefore to pile it in windrows. Windrows of snow, of course, occupy considerable space, so that it is necessary to allow for an increased area of ice.

The distance between the windrows depends upon the depth of the snow. It is advisable, however, to run them at right angles to the main channel through which the ice is floated. The area between the

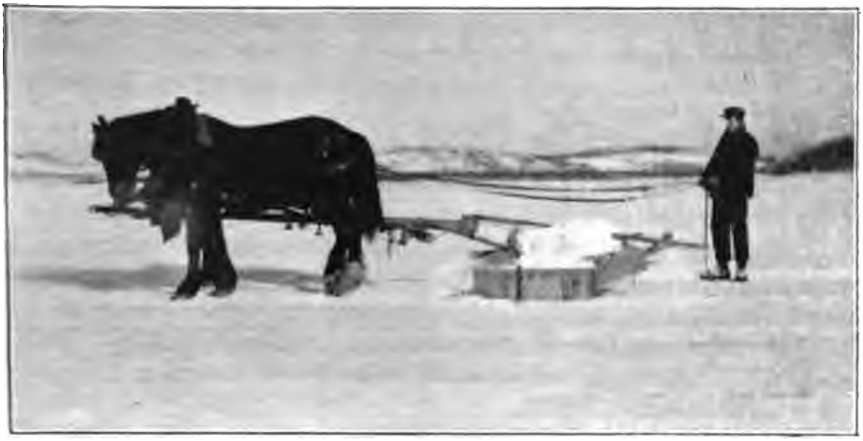

FIG. 4.—Scraping snow from ice field.

windrows then can be cut back any distance from the main channel, whereas if they run parallel to the main channel only that portion of the surface between can be cut before opening another channel. As the weight of the windrows of snow is usually sufficient to make the ice on which it is piled sink beneath the surface of the water, it is advisable, in order to prevent the water from overflowing the cutting surface, to cut a deep groove, or to cut through the ice parallel to and on both sides of the windrows.

WETTING DOWN THE FIELD.

Usually snow falls on the ice before it is thick enough to harvest. Since the weight of the snow has a tendency to sink the ice, advan-

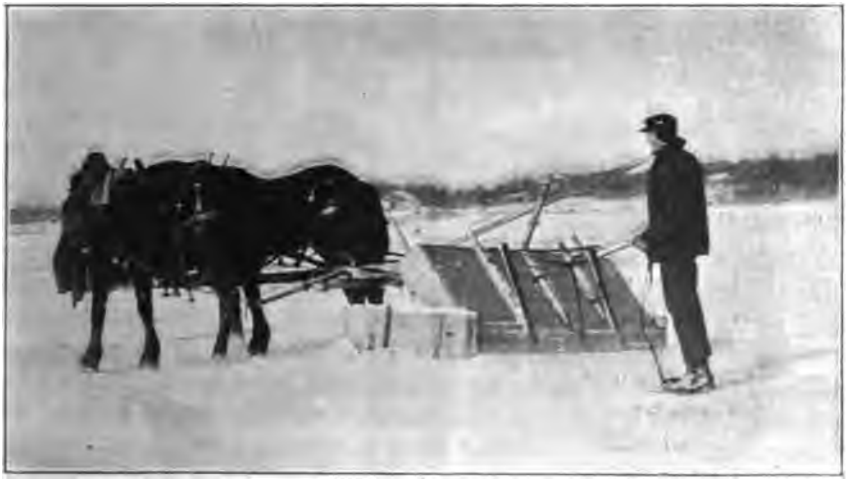

FIG. 5.—Dumping snow from scraper.

tage is sometimes taken of the layer of snow in forming ice. Holes are made in the ice, and water is allowed to rise through the openings and flood the surface. If the weather is very cold the mixture of snow and water quickly freezes and increases the thickness of the ice.

The surface should not be flooded, however, unless the weather is cold enough to freeze the melted snow solid. If only the top surface of the snow freezes, a crust forms which makes scraping difficult, and also injures the quality of the ice. In that case planing or scraping the crust of snow from the ice becomes necessary. The location and size of the holes for wetting down the surface should be planned so that the entire surface is completely covered with water. Ordinarily this is accomplished by small holes 1 or 2 inches in diameter and from 6 to 8 feet apart.

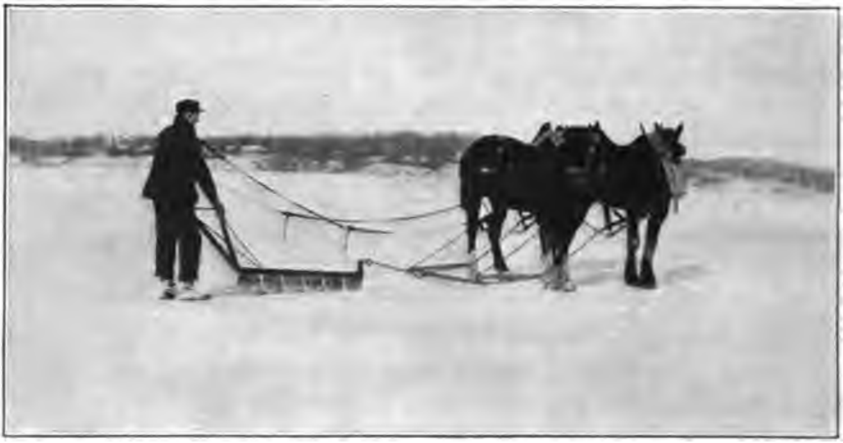

FIG. 6.—Plowing ice.

LAYING OFF THE FIELD.

After the snow is off the ice the field is ready to be marked for cutting. This must be done carefully so that all cakes will be rectangular, which facilitates economical handling and packing in the ice house. If a proper beginning is made in marking off the field, no trouble will be experienced, but if not, subsequent cuttings will be difficult. Success in marking depends largely on getting the first line straight, which may be accomplished by placing a stake at each end of the proposed line to serve as a guide. A straightedge, consisting of an ordinary board about 14 feet long, is then aligned with the two stakes and the cutting tool or hand plow run along its edge, after which the board is pushed forward and again aligned with the two stakes. This is continued until the entire distance between the stakes has been covered. Another way is to stretch a line between the stakes and do the marking with a hand plow, but this method is not so satisfactory, because the hand plow can not be run in so straight a line without the aid of the straightedge. After the first line is cut to a sufficient depth it can be used as a guide for the horse marker (fig. 6) if this tool is used.

After the field has been lined off in one direction the crosslines should be made. Care should be taken to have the crosslines at right angles to those first drawn, which is accomplished by the use of a square. A square suitable for the purpose can be made easily. First nail the ends of two boards together with a single nail. Measure a distance of 8 feet on the outer edge of one board and 6 feet on the outer edge of the other, then nail a third board diagonally across the two, adjusting it until the two marks are exactly 10 feet apart on a straight line. The boards should then be nailed together securely, forming the desired square as shown in figure 7. If the first crossline is drawn with care it is easy to draw the remaining lines parallel.

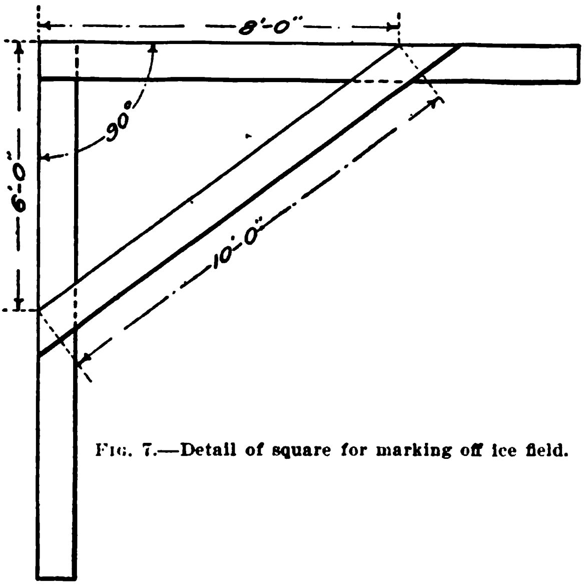

FIG. 7.—Detail of square for marking off ice field.

SIZE OF CAKES.

The size of the cakes depends to some extent on the thickness of the ice, as well as upon the tools available for harvesting, but in any case it is important to have all the cakes of the same size. In order to simplify the handling and packing, many farmers, especially those who harvest a comparatively small quantity of ice, cut the cakes 22 inches square, a size that is easily handled with a limited amount of equipment. Table 1 gives the number of cakes 22 inches square and of different thicknesses required for each ton of ice.

In the case of floe ice, which is always broken up, it is of course impracticable to obtain cakes of uniform size; consequently it is gathered and packed as well as possible. The ice axe is used to remove irregular corners and the small pieces are used to fill the holes around the irregular pieces in order to make the whole as solid as possible and to reduce to the minimum the quantity of entrapped air.

CUTTING.

After the field has been marked off, a strip of ice, one block in width (22 inches) and extending from the loadingway to the main channel, is cut through and forced under the surface of the surrounding ice. This strip should be sawed somewhat wedge-shaped, wider at the bottom than at the top, which allows it to be forced down under the field with ease. The operation is known as "sinking the header" and it opens up a small channel the width of the proposed cakes. The channel is widened by cutting another strip to enable the long strips or floats of ice to be floated from the main channel to the bank or loadingway.

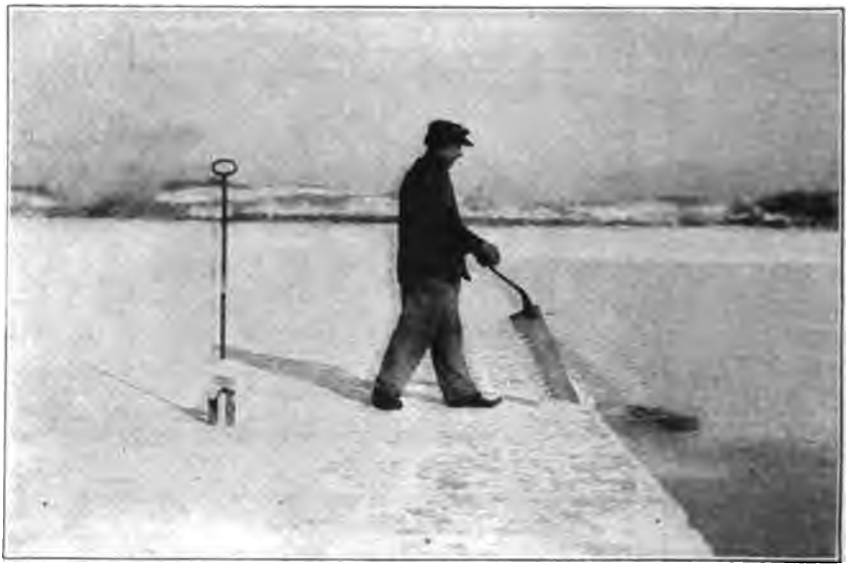

FIG. 8.—Sawing out floats.

The strips of ice are then pushed with an ice hook along the channel to the bank or loadingway, where they are sawed or chopped into cakes. (See figs. 8, 9, and 10, and illustration on cover.) The narrow channel, cut at right angles to the main channel, has the advantage of allowing the operator to get closer to the cakes and to handle them more easily. At the end of the narrow channel there should be an

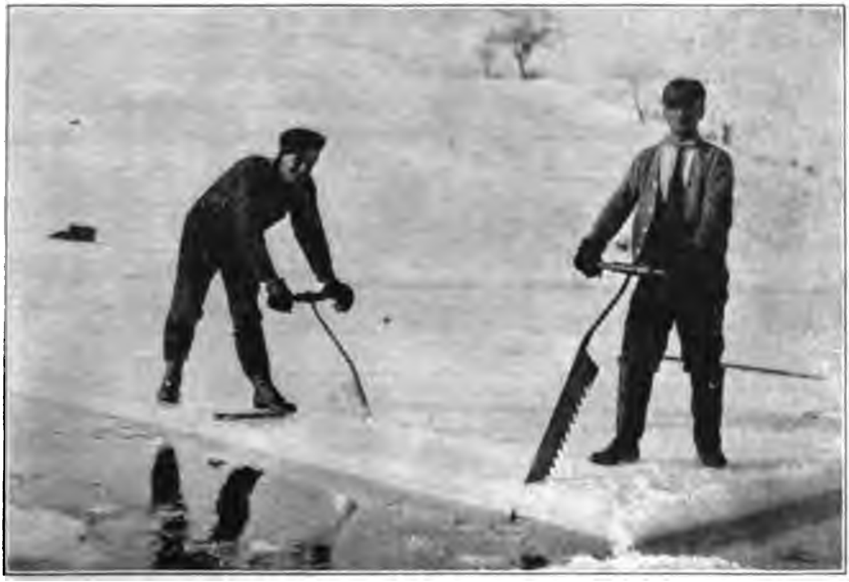

FIG. 9.—Cutting the ice.

inclined track or loadingway up which the cakes are drawn either by hand or by a horse. (See figs. 11, 12, and 13.) This track may lead directly into the ice house or to a platform from which the cakes are loaded upon a wagon or sled.

The cakes should not be cut completely through, but should be grooved 2 or 3 inches deep with the plow, and after being floated up

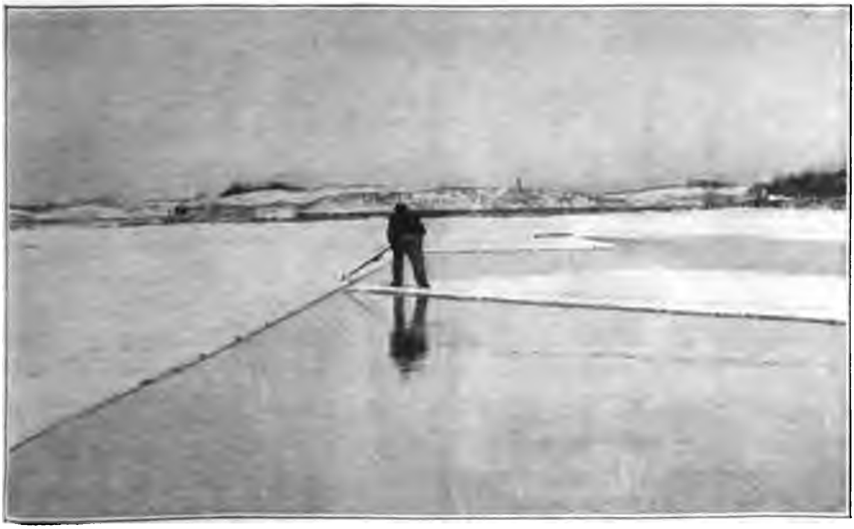

FIG. 10.—Floating large cakes of ice to shore to be cut into smaller ones.

the channel chopped through with a special tool before being put on the loadingway. This practice saves labor and time.

PACKING.

Loss of ice by melting depends partly upon the manner of packing. The cakes should be placed close together so that the mass will be as tight and solid as possible, thus preventing cracks and openings that will allow air to circulate. Perfectly cut rectangular cakes can be closely packed, which emphasizes the importance of special care in cutting to insure cakes of exactly the same size. When they are irregular in size the best plan is to fill up the openings with small pieces of ice in order to make the mass as tight and compact as possible. In order to insure close contact between succeeding layers no broken ice should be allowed to remain on top of or to protrude above the ice cakes.

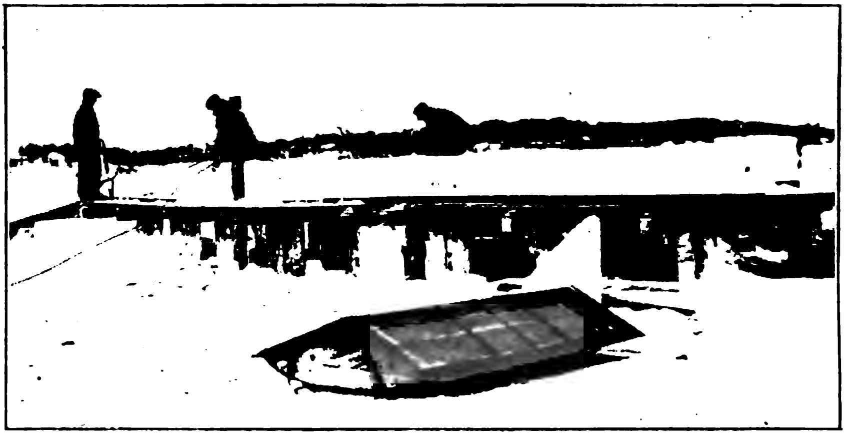

FIG. 11.—Drawing ice cakes from water to loading platform.

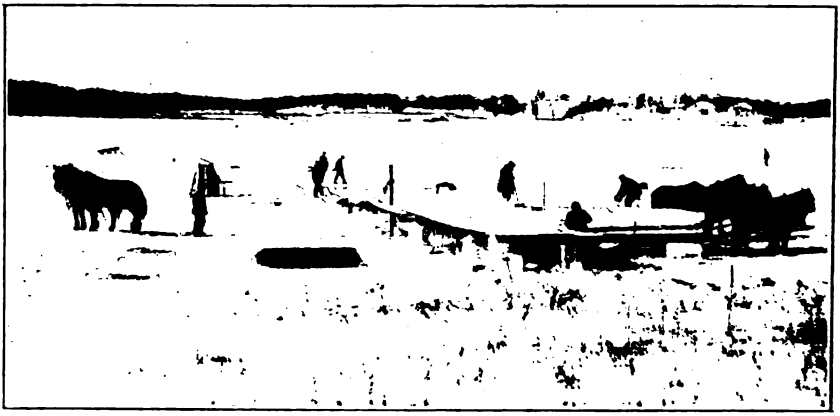

FIG. 12.—Harvesting and loading ice.

In the beginning a layer of dry sawdust about a foot thick should be placed in the bottom of the ice house, the depth of the sawdust being a few inches less in the center than at the outer edge, so that the cakes will have a tendency to slide toward the center instead of toward the walls. The sides of the mass of packed ice should be smooth. Any projecting pieces should be trimmed off before the mass is covered with insulation. If sawdust or mill shavings are used a space of at least 12 inches must be left between the sides of the ice stack and the walls of the building. This space is filled with dry sawdust or shavings as the packing in the center proceeds.

In packing small quantities of ice it is a common custom to pour water over the stack or mass of packed ice and allow it to freeze solid before putting the insulation in place. While undoubtedly this procedure assists in reducing the melting by closing the openings between the cakes, it has the disadvantage of making it more difficult to remove the ice when needed. It is then necessary to chop the cakes apart, which wastes considerable ice, so that little is gained in this way.

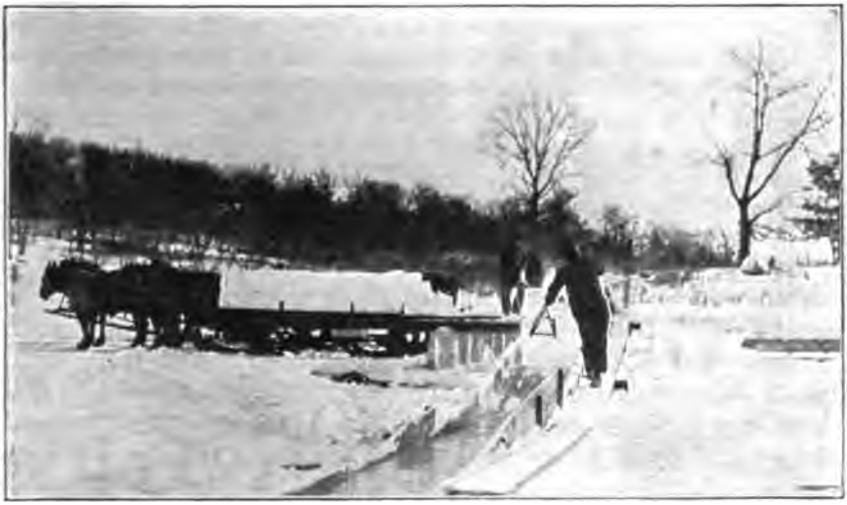

FIG. 13.—Loading cakes of ice on sleds for hauling to ice house.

TOOLS REQUIRED.

When a small quantity of ice is to be harvested few tools are required. The following list contains those actually needed: Two ice saws, 1 hand marker, 1 pulley and rope, 2 pairs of ice tongs, 2 ice hooks, 1 pointed bar or splitting fork, and 1 straightedge. Besides these essential tools, additional ones, such as a horse plow and marker, horse scraper, and a calking bar are convenient and will help to expedite the work. The amount of the equipment depends on the quantity of the ice to be cut and on local conditions for handling ice. If the harvesting must be done quickly, to take advantage of the weather, extra equipment will be justified. Neighbors may cooperate advantageously in cutting and storing their ice and in owning equipment jointly.

COST OF HARVESTING ICE.

The cost of harvesting ice also varies with local conditions. It is impossible, therefore, to give an estimated cost that will cover all cases. The ice-harvesting season fortunately comes at a time when there is the least work on the farm for men and teams, and consequently the actual money cost is usually not very great. Investigations have indicated that counting the full value of the men's time, the average cost of cutting ice is about 3 cents for a cake 22 inches square and 14 inches thick, or about 27 cents a ton. Add to this the cost of packing and hauling, and the average cost of a ton of ice is about $1.50, when the ice house is near the source of supply. If the ice house is at a considerable distance the cost of hauling, of course, is increased, and the total cost of storing ice in some instances has amounted to $3 or more a ton.

QUANTITY OF ICE REQUIRED FOR A DAIRY FARM.

The quantity of ice needed for a dairy farm depends on its location, number of cows milked, and methods of handling the product. In the Northern States it has been found that with a moderately good ice house, where the shrinkage from melting is not more than 30 per cent, half a ton of ice per cow is sufficient to cool the cream and hold it at a low temperature for delivery two or three times a week. It must be understood, however, that suitable cooling tanks are necessary under this estimate. The half-ton-per-cow estimate for ice to be stored allows for a reasonable waste and also for ordinary household use. If whole milk is to be cooled the quantity of ice stored must be increased to 1½ tons per cow in the North and 2 tons per cow in the South. To meet the needs of the average family on a general farm it will be necessary to store about 5 tons.

ICE HOUSES.

CAPACITY OF ICE HOUSES.

A cubic foot of ice weighs about 57 pounds, so in storing ice it is customary to allow from 40 to 50 cubic feet per ton for the mass of ice, but the quantity that an ice house of a given size will hold depends upon the manner in which the ice is stored. Generally a cubic foot of an ice house will hold the quantities given below:

	Pounds.
Ice thrown in at random, about	30 to 35
Ice thrown in in irregular pieces and broken sufficiently to pack closely	35 to 40
Ice piled loosely	40 to 45
Ice piled closely and with very slight crevices between	45 to 50

Unless the ice house has permanently insulated walls, at least 12 inches must be left between the ice and the wall of the building for insulation, and an equally large space for insulation must be allowed beneath and above the ice. From this it is possible to calculate readily the quantity of ice that any given house will hold. Thus, allowing 45 cubic feet per ton, an uninsulated ice house 18 by 12 by 10 feet high, allowing 1 foot around the ice for insulation, will hold about 38 tons, while the same-sized house if insulated will hold about 43 tons.

Loss by melting is in proportion to the surface area exposed to the air or packing material; hence it is advisable to store ice in the form of a cube, or as nearly so as possible. However, a square ice house without a gable roof is not desirable because its capacity is not so great as that of a square house of equal cubical content up to the plate line and roofed with a gable. A gable roof allows of a greater height of the filling door, thus permitting the storage of a larger quantity of ice, and affords better ventilation and ease of handling. Table 2 gives the inside dimensions of insulated houses for various quantities of ice. For uninsulated houses the dimensions should each be increased 2 feet.

TABLE 2.—*Inside dimensions of insulated ice houses for various quantities of ice.*

Quantity of ice.	Length.	Width.	Height.
Tons.	*Feet.*	*Feet.*	*Feet.*
10	10	7	7
20	14	8	8
25	14	10	8
30	14	10	10
40	18	10	10
50	16	12	12

LOCATION.

The selection of a site for an ice house is very important. Other conditions being suitable, the ice house on a dairy farm should be placed as near as possible to the milk house, in order to reduce the labor of handling and to encourage the more liberal use of ice. On a general farm the ice house should be located near the residence. To facilitate drainage the ground on which the ice house stands should be porous and slope from the building. Advantage also may be taken of the nearness of hills, trees, or buildings, which often afford protection from hot winds, thus saving ice.

ICE PITS.

If a suitable, well-drained location is available and only a small quantity of ice is to be stored, a pit may be used to advantage for storing ice. (See fig. 14.) The site selected should be sloping in order that a drain may be placed under the floor of the house. This drain may be of porous tile or may be simply a trench packed with small stones or gravel. If a tile drain is installed it should be properly trapped to prevent the entrance of warm air into the pit. The trap should be placed outside of the building where it will be accessible in case the drain becomes clogged. The trap may be placed where the drain discharges upon the ground but as a stoppage may occur between the building and the trap it is better to place it close to the foundation wall. The trap should be of the handhole type with a terra-cotta stopper made air-tight with a light pointing of cement which may easily be removed when necessary. The drain should not be laid near trees, as the tree roots will find their way to the drain, causing a stoppage in a very short time. The purpose is to provide adequate drainage; otherwise the bottom of the pit will be flooded with water from melted ice or from seepage.

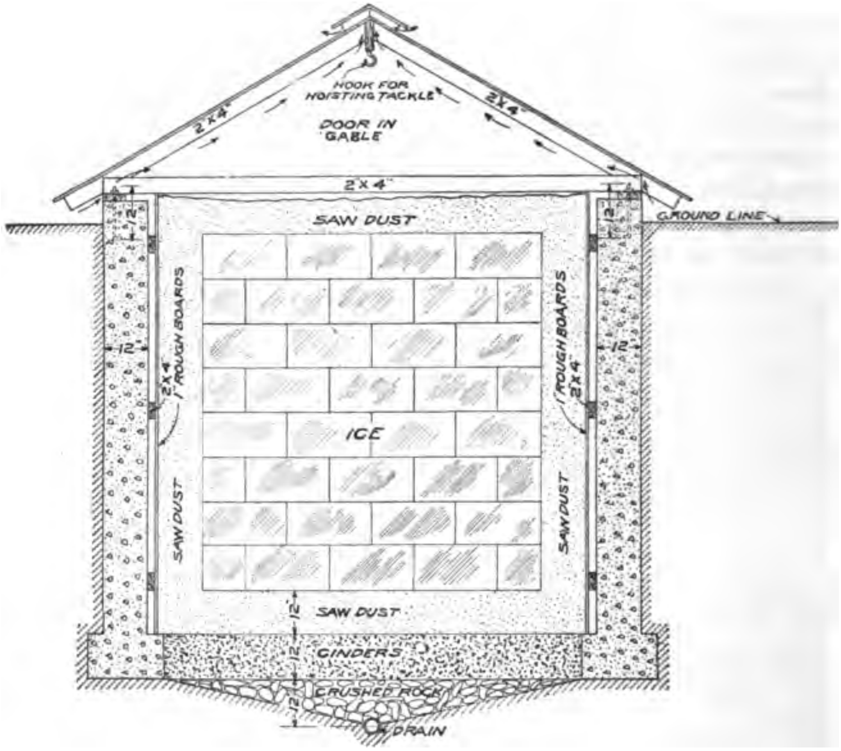

FIG. 14.—Underground ice house.

The floor of an ice pit should consist of 12 inches of crushed rock or coarse gravel tamped into place, on top of which are 12 inches of cinders also well tamped. The walls should be 12 inches thick made of concrete mixed in the proportion of 1 part of Portland cement to 3 of sand and 5 of crushed stone or gravel. Waterproofing the walls is unnecessary, since provision for drainage is made in the bottom of the pit. No ceiling is required, and the roof may be constructed as shown in figure 14. The door will be needed in the gable.

Drainage inside the pit is provided by sloping the floor toward the center and having the water pass into the tile or gravel drain already described.

ICE-HOUSE CONSTRUCTION.

The construction of the ice house depends to a great extent upon local conditions, the size of the house, and the difficulty of obtaining ice. These factors help to determine the sum that may wisely be spent for such a building. Where ice is expensive or hard to obtain, a better constructed and insulated and therefore more expensive ice house is advisable. Where natural ice can be harvested and stored cheaply a cheap structure is usually satisfactory and the loss from melting ice is a small consideration.

The cost of harvesting and storing, the interest on the money invested, and repairs and depreciation on the building are to be considered in relation to the ice loss from melting; and the type of house to be built depends upon these factors. It never pays to build permanently in other than a substantial manner, and careful thought should be given the matter before erecting a cheap makeshift that will not give adequate service.

INSULATION.

An ice house should be built where it will be shielded as much as possible from the wind and from the direct rays of the sun. The object is to prevent the outside heat from passing into the interior and melting the ice; consequently every effort must be made to resist the passage of heat by placing in the walls a material or a form of construction which will reduce the transfer of heat from the outside to the inside. No material known will entirely prevent the passage of heat, but several, called nonconductors or insulators, offer a high resistance to its passage. The best insulators appear to be those that contain entrapped air in the greatest number of small spaces. Their value also depends upon the density to which they are packed; if too loosely they will permit air circulation, if too closely they will cause the conduction of heat to a greater degree. Most of the materials in use give the best results when packed to a density of from 8 to 10 pounds per cubic foot.

Formerly in constructing buildings for the storage of ice or for cold storage, a space as much as 12 inches wide was provided in the walls. It has been found, however, that an air space 1 inch wide is practically as valuable as one 12 inches wide. Air circulation is useful between the insulated ceiling and the roof of the ice house, for there it tends to break up the heat radiation through the roof. No openings in the ice chamber permitting entrance or exit for air, especially at or near the ground line, should be allowed in a building where ice is stored, as the cold currents of air tend to filter to the outside. If the walls and foundations are kept absolutely tight at the bottom an opening at the top has little effect, because the warm air entering remains at the top of the room. When ice is to be removed from the house, the door should be kept open as short a time as possible, and if a covering material, such as sawdust, is used, it is important to replace it after the ice has been removed. In a properly insulated ice house no covering for the ice is needed. It is merely packed on the floor of the room and depends on the insulated walls for protection from the outside heat.

In the cheaper ice houses, which do not have properly insulated walls, sawdust or mill shavings are commonly used to protect the ice. A layer of that material should be placed on the floor to a depth of about a foot and the ice stacked upon it, a layer at a time. Ice will melt rapidly if placed directly on the ground, because moist ground is a fairly good conductor of heat. Sawdust and shavings, it may be explained, are not the best insulators for this class of building, but are used because they are cheap, are available in many parts of the country, and if kept dry are good insulators. As it is difficult to keep them dry, however, great care should be used in the construction of the walls in order to exclude moisture. The outer wall covering should be practically air-tight, since if it is not, moisture will find its way in with the air, flow through the filling material, and condense on the cold inner wall. The result is the gradual saturation of the insulating material and its consequent loss of value as an insulator.

For insulating purposes planing-mill shavings are better than sawdust, because they are elastic, do not settle so readily, do not absorb moisture so rapidly, and are free from dirt, bark, and chips. When used as filling for walls or ceiling they should be well packed into place to prevent settling. Sawdust has been in common use for insulating because it usually could be obtained easily and at little or no cost. It has the disadvantage, however, of nearly always being damp, a condition which destroys its insulating value and favors the growth of mold and rot both in the sawdust and in the walls of the building. The rotting generates heat and also causes the sawdust to settle, thus leaving open spaces which further decrease the insulation. When sawdust is to be used it should be dried thoroughly before it is put into place. It can be dried by spreading out to a depth of about 6 inches and exposing it to the air and sunshine for a few days. Stirring will hasten the drying.

There are several kinds of commercial insulation which are much more effective than either sawdust or shavings, and while their first cost is somewhat greater, in the end they are usually cheaper. Their insulating value is uniform and moisture has little effect on them. In addition they are practically fireproof, occupy little space, and retain their efficiency a long time. Experienced workmen must install such insulation if best results are to be obtained.

DRAINAGE.

Good drainage is essential for satisfactory ice storage. In houses where the floor is below the ground level drainage enough usually can be obtained through the soil if it is porous. With a clay soil it may be necessary to excavate a foot or two and fill it with gravel or cinders or to place a 3-inch porous tile drain under the floor. The drain should be trapped or sealed outside of the walls to prevent warm air from entering the building through the floor. Dry soil affords better insulation than wet earth; hence it is advisable, where subsurface water is likely to keep the ground under the house damp, to lay a tile drain around the outside of the foundation walls (fig. 15). In place of the tile a drain may be made of crushed rock and gravel, packed in a manner similar to that described under ice pits.

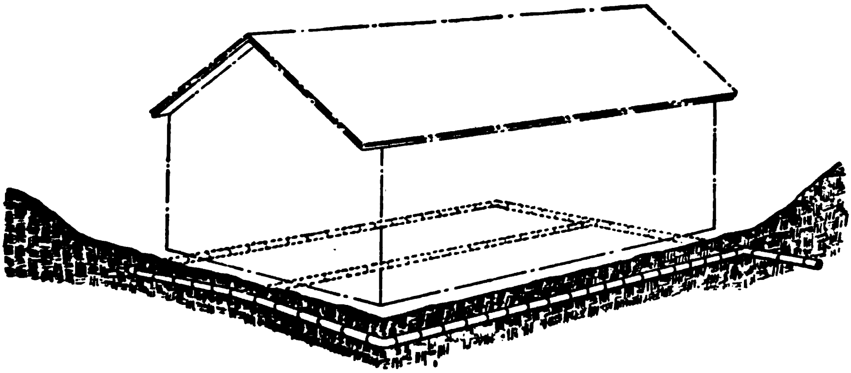

FIG. 15.—Tile drain and foundation walls.

As in the case of pits, the floor of the ice house should slope toward the center to keep the ice in a campact mass and to carry the water to the drain.

VENTILATION.

Whatever the construction of the building, there is certain to be more or less melting that will cause moisture to appear on the walls and ceiling. If the building is of wood the moisture is absorbed by the wood and decay follows. Wooden ice houses, therefore, should have a means of ventilation which can be controlled and the ceiling should slope to the center to assist circulation and carry warm, moisture-laden air to the ventilator. A house equipped with commercial insulation, that is, covered inside with a cement finish, needs no ventilators from the ice chamber, but as shown in the plans (fig. 21a) the building should be so constructed as to afford a circulation of air through the outer walls and from the eaves to the ventilator on the roof. The resulting air currents tend to break up the heat radiation through the walls and roof.

WATERPROOFING.

It is of great importance that brick, concrete, and wooden buildings be waterproofed on the inside. Brick and concrete may be readily waterproofed by painting the walls with a suitable paint or waterproofing compound, such as preparations of paraffin and asphalt. Paraffin and asphalt should be applied hot and in addition the walls should be heated before the application. There are on the market several water-excluding paints and compounds for preserving wood. Creosote is considered one of the best preservatives provided the wood is thoroughly impregnated with it, but on account of its odor it is objectionable in houses where food products are stored.

GENERAL SPECIFICATIONS FOR VARIOUS TYPES OF ICE HOUSES.

POST ICE HOUSE, UNINSULATED.

Floor.—Consists of 12 inches of coarse gravel tamped into place as shown in figure 16.

Walls.—Posts about 3 feet center to center are set up as indicated in figure 16, extending 3 feet into the ground and capped by a plate made of two pieces of 2 by 4 inch material; the inside is sheathed with 1-inch boards. The posts and boards below the ground should be treated with some preserving compound.[1]

Ceiling.—No ceiling is provided.

Roof.—The type of roof used is shown in figure 16.

Doors.—A door may be provided by cutting out the boards between two posts in the end of the house and closing the opening by placing short boards across on the inside and packing sawdust against them to keep them in place.

Drainage.—Drainage is obtained by sloping the floor of the house so that the water will run to the center. A ditch should be dug as indicated, and filled with gravel and small stones. This ditch should empty outside at a point where there is sufficient fall to carry the water away. A 3-inch porous drain tile may be provided, as shown in figure 17. It should be properly trapped to prevent the entrance of warm air.

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[1] For information in this connection reference is made to Farmers' Bulletin 744, entitled "The Preservative Treatment of Farm Timbers."

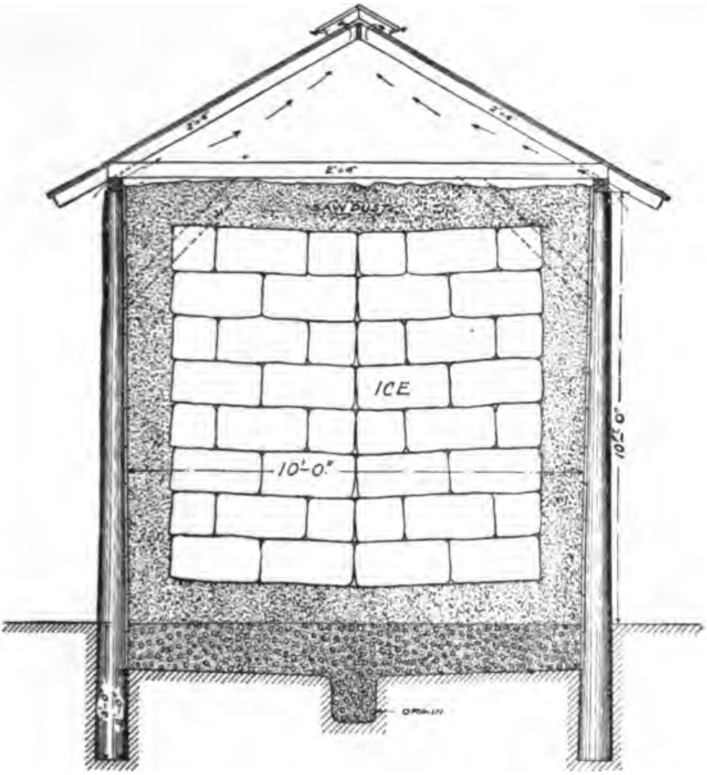


FIG. 16.—Post ice house, uninsulated.

FRAME ICE HOUSE, UNINSULATED.

Floor.—Consists of 12 inches of coarse gravel tamped into place, as shown in figure 17.

Walls.—On a 2 by 10 inch mudsill 6 by 6 inch sills are placed with 2 by 4 inch studs spaced about 2 feet center to center; on the inside of the studs 1-inch boards are nailed. The studding is capped as indicated. Both mudsills and sills should be treated with creosote.

Ceiling.—No ceiling is provided.

Roof.—The type of roof used is shown in figure 17.

Doors.—A door may be provided as suggested for the post ice house.

Drainage.—Drainage is provided by sloping the floor toward the center. Either a ditch such as is described under post ice house or a 3-inch porous drain tile may be used to carry off the water. The same requirements are necessary as in the post ice house.

OPEN-TYPE ICE HOUSE, UNINSULATED.

Figure 18 illustrates a small frame ice house such as is recommended by the Rochester (N. Y.) health board.

Floor.—Should consist of 12 inches of crushed stone or coarse gravel well tamped into place.

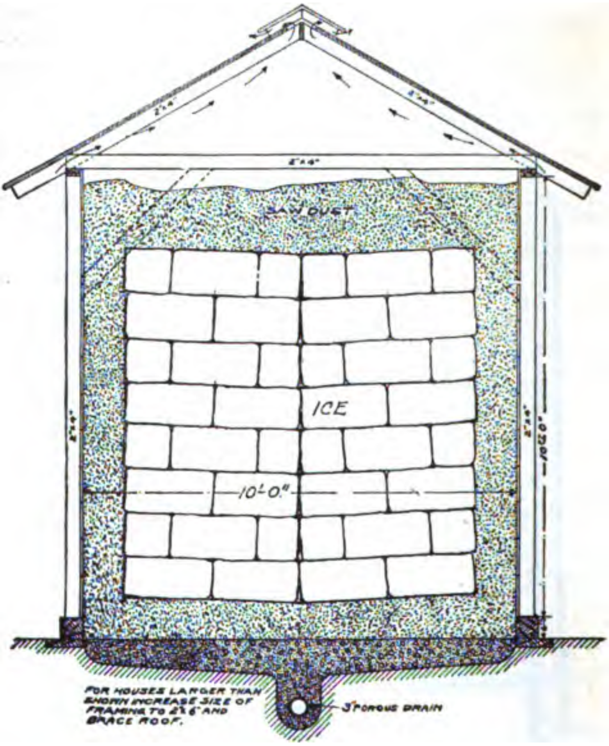

2"x4"
2"x4"
2"x4"
SAW DUST
ICE
2"x4"
2"x4"
10'-0"
10'-0"
FOR HOUSES LARGER THAN SHOWN INCREASE SIZE OF FRAMING TO 2"x 6" AND BRACE ROOF.
3" POROUS DRAIN

Fig. 17.—Frame ice house, uninsulated.

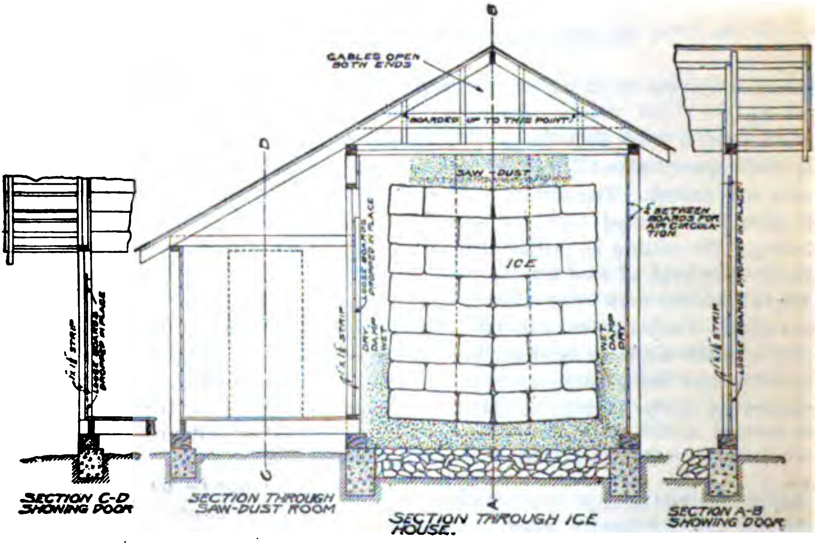


Fig. 18.—Open type ice house.

Walls.—The walls consist of 2 by 4 inch studs spaced about 2 feet center to center and erected on 6 by 8 inch sills. On the inner side of the studs are placed 1-inch rough boards with a ½-inch space between. The object of the open construction is to dry out the outer layers of sawdust around the ice.

Ceiling.—No ceiling is provided. The gables are left open to permit circulation of air over the ice.

Doors.—Doors are constructed as shown and consist of loose boards dropped into place.

Drainage.—Drainage is provided by sloping the floor toward the center of the house. If the house is built on porous soil no drain will be needed; otherwise one of the forms of drainage described under post ice house should be used.

Roof.—The roof is constructed as shown in figure 18 with an overhang of about 2 feet to prevent rain from blowing in on the top of the ice.

Sawdust room.—A storage room for sawdust should be constructed as shown in figure 18.

WOODEN ICE HOUSE, INSULATED WITH SAWDUST OR MILL SHAVINGS.

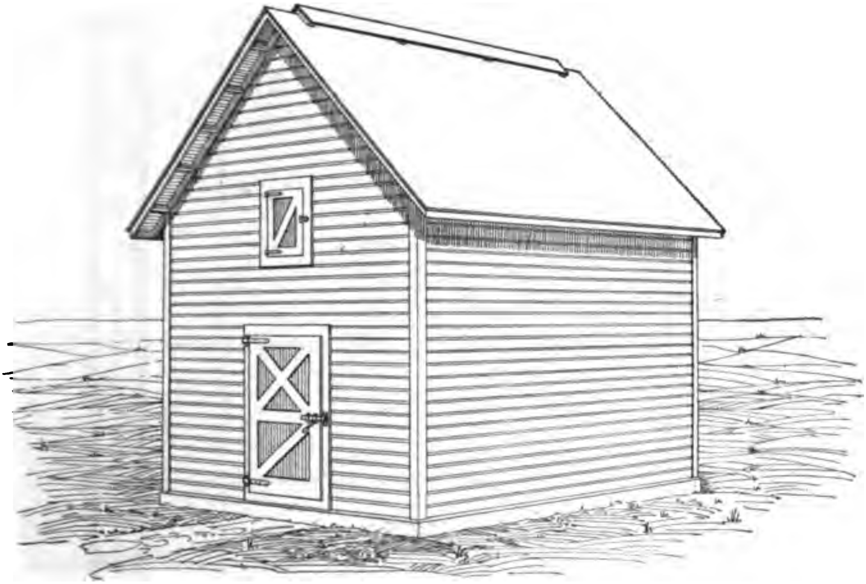


FIG. 19.—Wooden ice house, insulated with sawdust or mill shavings. (Perspective view.)

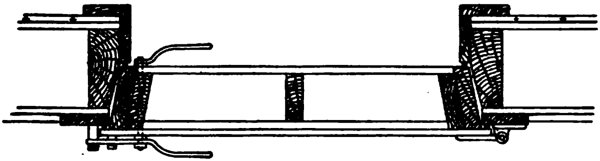
Figures 19 and 20 illustrate an ice house with and without a milk room.

Framing.—All framing should be dried, square edged, sawed fair and full to the sizes given, and should not contain any of the following defects: Wormholes, shakes, heart pith, warped, twisted, or unevenly sawed lumber, and unsound knots. The sizes used are shown in the various figures.

Boards.—All boards used should be thoroughly dried and free from loose knots, heart centers, shakes, or splits, should be dressed, tongued-and-grooved, and all unsound boards rejected.

Paper.—Only heavy waterproofed insulating paper should be used. Ordinary building paper is not satisfactory. Double thickness of paper is used in all cases, each layer lapping 6 inches over the preceding one. The layers extend continuously around all corners, and breaks should be carefully covered.

Insulation.—When shavings or sawdust are used they should be thoroughly dried and free from dirt, chips, and bark and be well packed into place. When commercial insulation is used and installed by the manufacturers it is usually guaranteed not to transmit more than a certain amount of heat under given conditions.



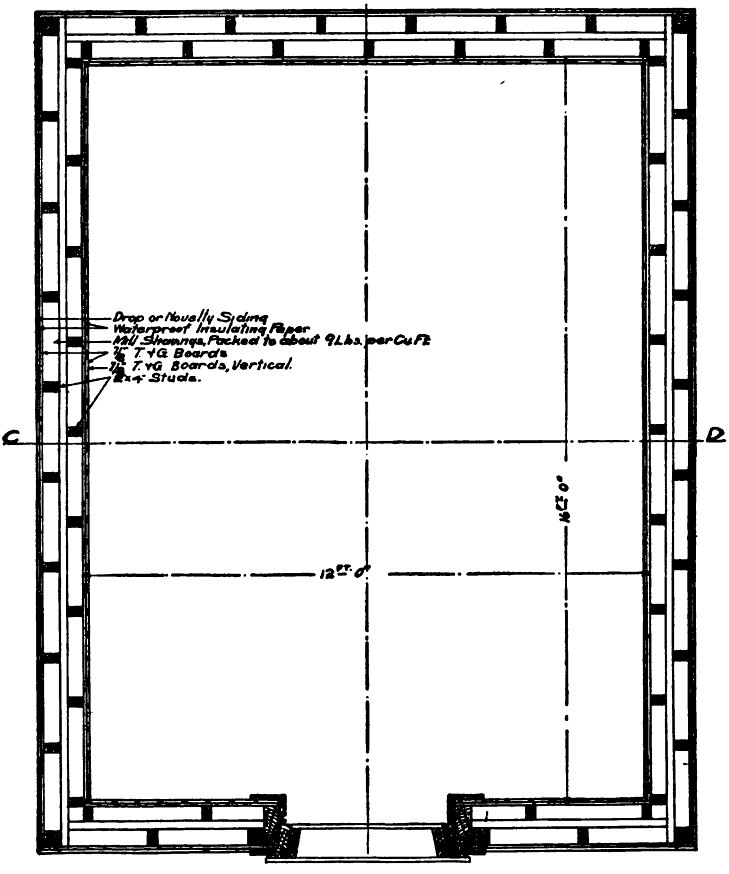

Drop or Novelty Siding
Waterproof Insulating Paper
Mill Shavings, Packed to about 9 Lbs. per Cu. Ft.
7/8" T.&G. Boards
1/2" T.&G. Boards, Vertical.
2x4" Studs.
C
D
16 FT. 0"
12 FT. 0"

FIG. 19A.—Wooden ice house, insulated with sawdust or mill shavings.

Carpenter work.—This always should be executed in a substantial and workmanlike manner.

Excavating and grading.—To get a firm and solid footing the area should be excavated for the floor and foundation. The entire floor should be graded to the level shown in figure 19b, and rolled and tamped until solid.

Foundation.—Footings should be of stone or concrete of the size shown in figure 19b and of sufficient depth to insure a solid foundation.

Floor.—If obtainable, coal cinders should be used in preference to sand, gravel, or crushed rock to cover the ground area of the building. The depth of the layer of cinders which forms the floor is 12 inches and the cinders should be well tamped into place.

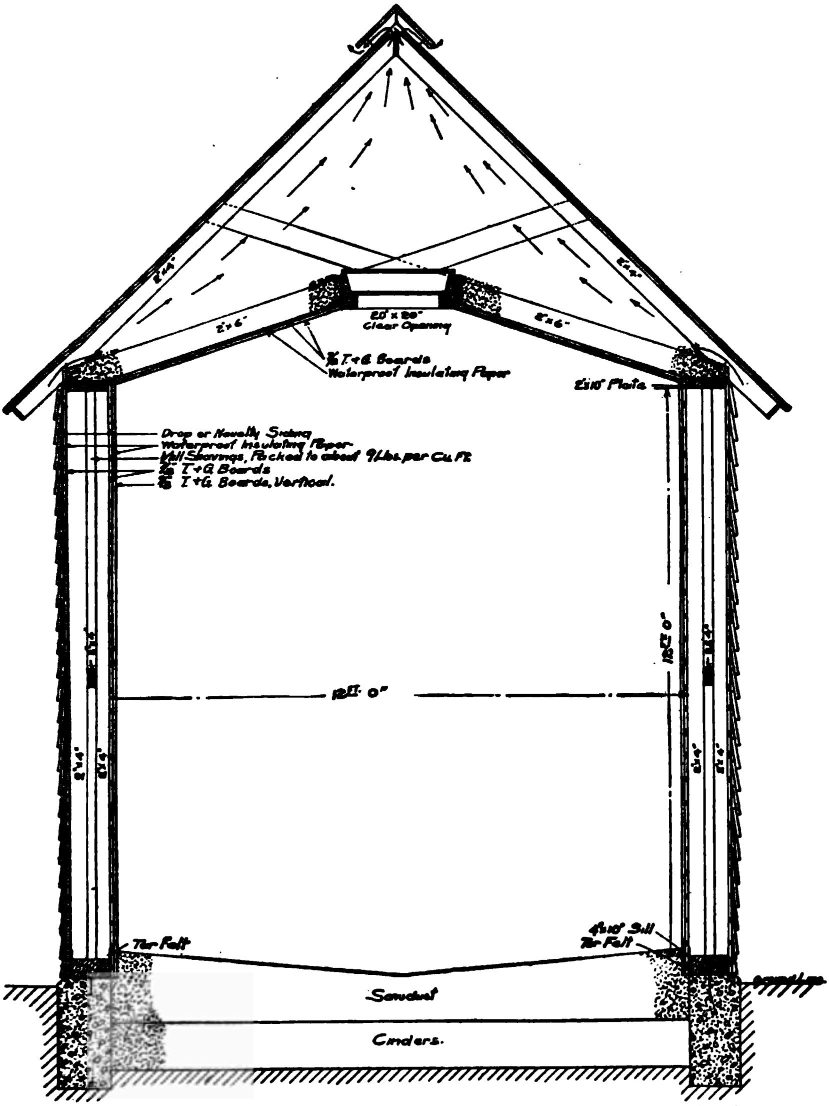


FIG. 19B.—Wooden ice house, insulated with sawdust or mill shavings. (Section on *C–D* of fig. 19a.)

Walls.—Double rows of 2 by 4 inch studs should be staggered with one 2 by 4-inch tie, as shown in figure 19b. These are covered on the outside with one layer of ⅞-inch tongued-and-grooved boards. On the outside of this, two layers of waterproofed insulating paper are placed and this covered with a good quality of ship-lap siding. For the inside of the room one layer of tongued-and-grooved boards is laid directly on the studs, then two layers of insulating paper and finally a course of ⅞-inch tongued-and-grooved boards. The insulating paper should extend continuously around the corners and be lapped at least 6 inches.

Ceiling.—The ceiling is constructed as shown in figure 19b, with one course of ⅞-inch matched boards nailed to joists, then two layers of waterproofed insulating paper followed by a course of ⅞-inch tongued-and-grooved boards.

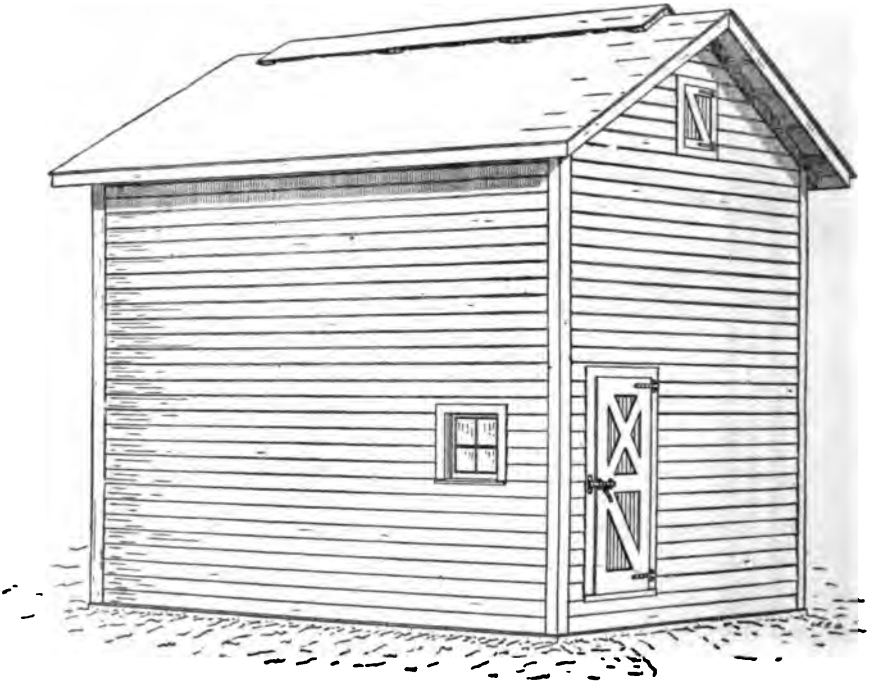


FIG. 20.—Wooden ice house, with milk room, insulated with sawdust or mill shavings. (Perspective view.)

Roof.—The roof is fitted with 1-inch roof boards covered with a good quality of shingles laid 4½ inches to the weather and securely nailed. Prepared roofing may be used instead of shingles, with good results.

Doors.—The doors are constructed as shown in the detail in figure 19a, and should be of a good quality of seasoned lumber. Commercial doors can be bought at a reasonable price and probably will be more satisfactory than those made by a carpenter inexperienced in this kind of work.

Drainage.—Thorough drainage is provided by a floor of 12 inches of cinders well tamped into place. If necessary either a drainage ditch or a porous tile, as described under post ice house, may be used.

Ventilation.—Ventilation is provided as shown in figure 19b.

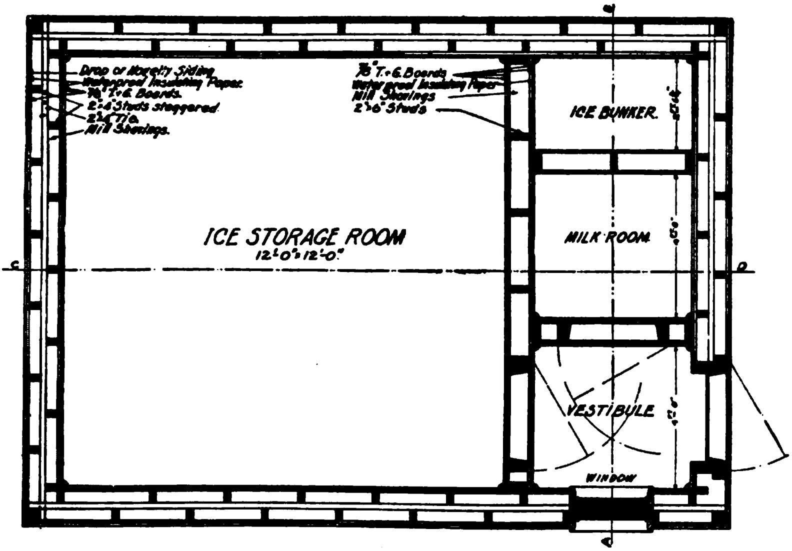


Fig. 20A.—Wooden ice house, with milk room, insulated with sawdust or mill shavings.

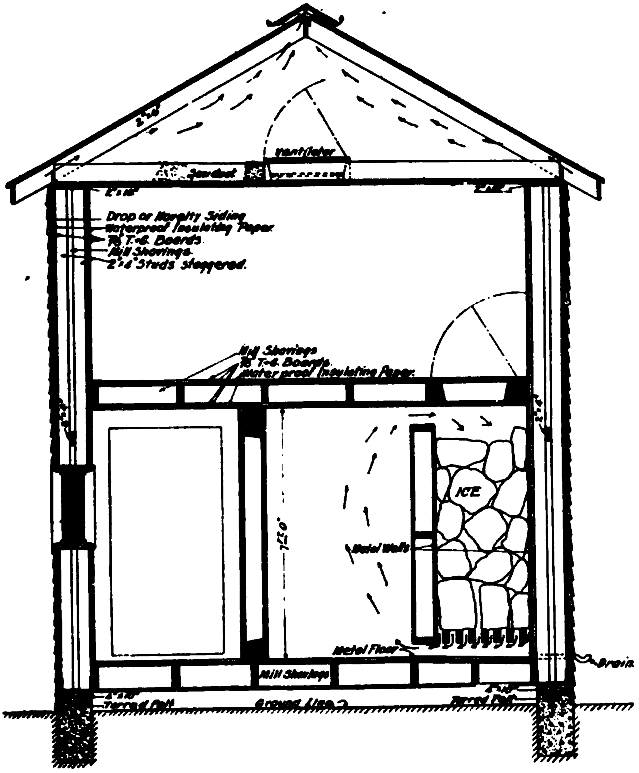


Fig. 20B.—Wooden ice house, with milk room, insulated with sawdust or mill shavings. (Section on *A–B* of fig. 20A.)

FRAME ICE HOUSE WITH COMMERCIAL INSULATION.

Floor.—After excavating to a proper depth, depending on the character and lay of the soil, lay a 4-inch concrete base; cover this with hot asphalt, and lay directly on it 3 inches of good commercial insulation with all joints fitted. This in turn is covered with a layer of hot asphalt followed by a 2-inch layer of concrete. Finally finish with ½-inch Portland-cement mortar and smooth. The floor should incline 1 inch to 4 feet in the direction of the center drain.

Walls.—Set up 2 by 6 inch studs as shown in figure 21a and cover on the outside with drop or novelty siding. On the inside the studs should be covered with a course of ⅞-inch tongued-and-grooved boards followed by a layer of waterproofed insulating paper. Upon this securely nail to the wall 3 inches of good commercial insulation and follow with a ½-inch Portland-cement finish.

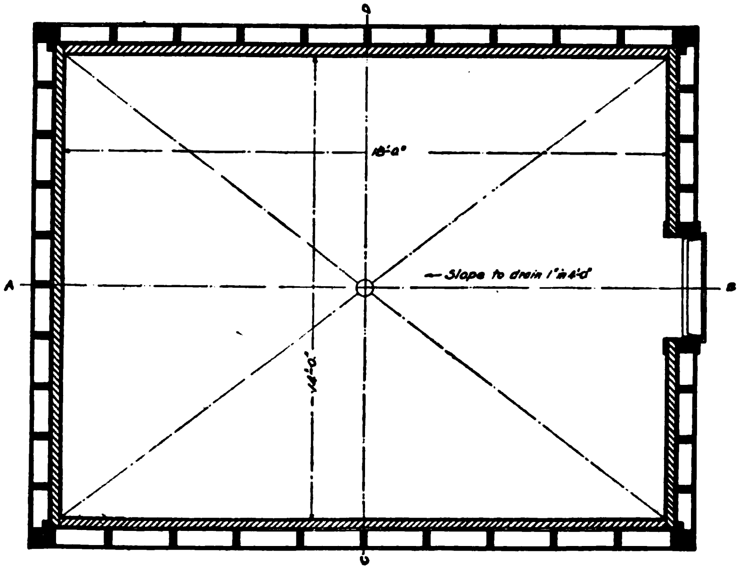


FIG. 21.—Frame ice house with commercial insulation. The perspective view in figure 19 also illustrates this plan. (Ground plan.)

The space between the studs is to be provided, as shown in figure 21a, with an opening at the top and bottom for the circulation of air.

Ceiling.—The ceiling is made of one course of ⅞-inch tongued-and-grooved boards nailed directly on the joists and then covered with one course of waterproofed insulating paper, followed with 2 inches of good commercial insulation, nailed directly to the ceiling. It is finished with ½-inch of Portland-cement plaster. For additional insulation a layer of dry sawdust from 6 to 12 inches may be placed on top of the ceiling.

Roof and doors.—The same type of roof and doors may be used as in the other ice houses.

Drainage.—The floor should slope 1 inch to 4 feet toward the center drain. A 3-inch glazed tile drain should lead from the center of the floor to a convenient point outside the building, with a sufficient fall to carry the water off. The drain must be properly trapped to prevent the entrance of warm air.

A SMALL CONCRETE ICE HOUSE.

The building illustrated in figure 22 may be constructed of solid concrete or concrete blocks. The foundation trenches should be dug 10 inches wide and 2½ feet deep and filled with concrete in the proportion of 1 part Portland cement, 2½ parts sand, and 5 parts crushed rock. Above the ground level the walls may be made of either concrete blocks laid up in a 1 to 2 cement-sand mortar, or of solid concrete. For the solid walls above the ground level, the concrete should be proportioned 1 part Portland cement to 3 parts sand and 5 parts crushed rock, or 1 part cement to 6 parts of clean bank-run gravel. Bank-run gravel generally is not clean nor are the large and small aggregates in proper proportion. It should be screened and remixed in correct proportion, else the concrete may be of poor quality.

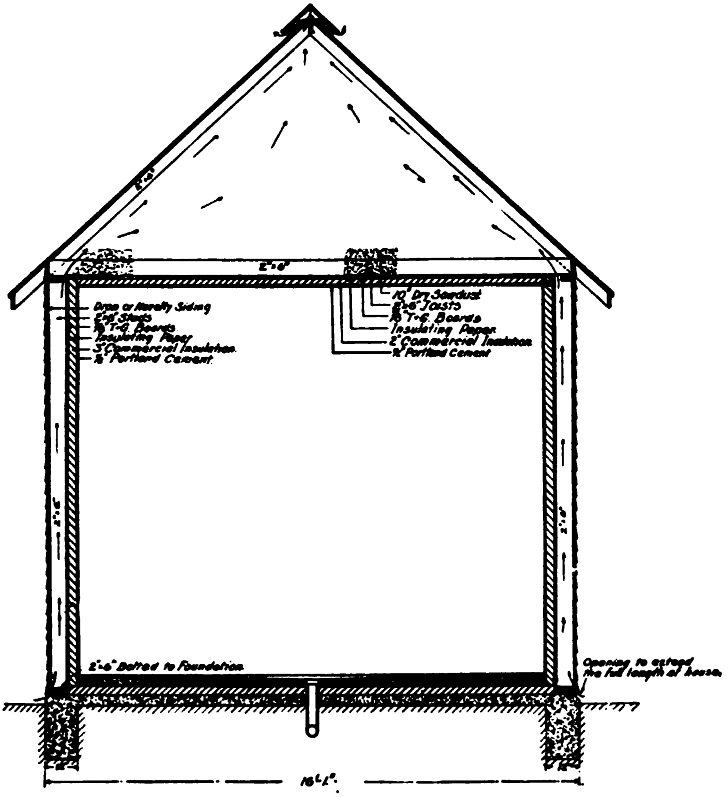


FIG. 21A.—Frame ice house with commercial insulation. (Section on *C–D* of fig. 21.)

In building up the concrete walls, movable forms are used for holding the wet concrete in place until it hardens. The forms should be 3 feet high and should extend entirely around the building. After filling the forms with concrete it should be allowed to stand until it sets and then the forms may be loosened, moved up, and again filled.

Three-eighths-inch steel reinforcing rods, spaced 18 inches apart and running in both directions, should be placed in the freshly poured concrete. The rods should be arranged alternately or staggered so that half of them will be placed

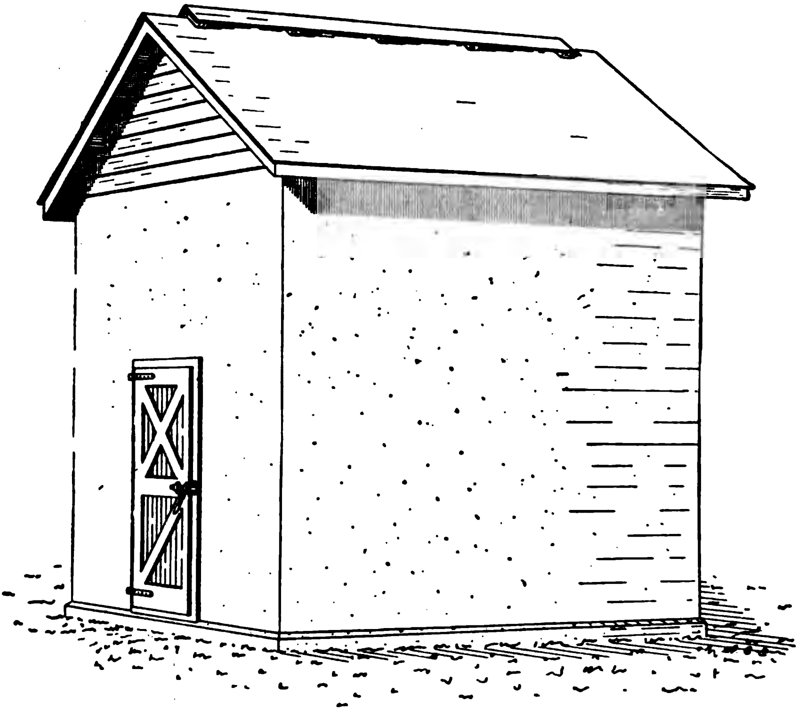


FIG. 22.—A small concrete ice house. (Perspective view.)

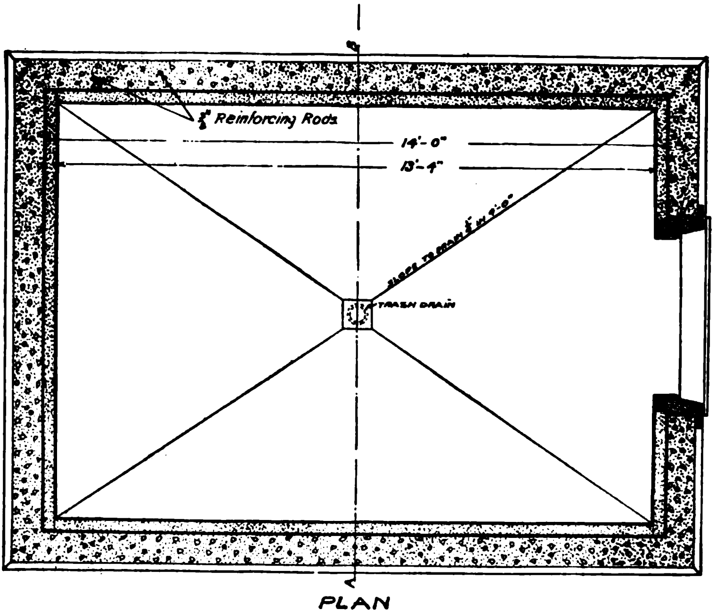


FIG. 22A.—A small concrete ice house.

3 inches from the outside edge and the other half 3 inches from the inside of the wall. In the concrete above the door opening, embed two rods or an old wagon tire cut in two and straightened. For holding the plates on top of the walls ½-inch bolts 10 inches long should be sunk head down 6 inches deep in the concrete. Concrete has very little value as insulation; hence in an ice house of this type it is necessary to use insulating material in the construction of the floor and walls.

The floor is made in layers. First 4 inches of concrete is laid on the ground. On top of the concrete 3 inches of cork-board insulation embedded in hot asphalt is placed, and this is followed with 2 inches of concrete, sloped 1 inch to 4 feet to the center drain. The floor should be finished smooth with ½-inch Portland-cement mortar.

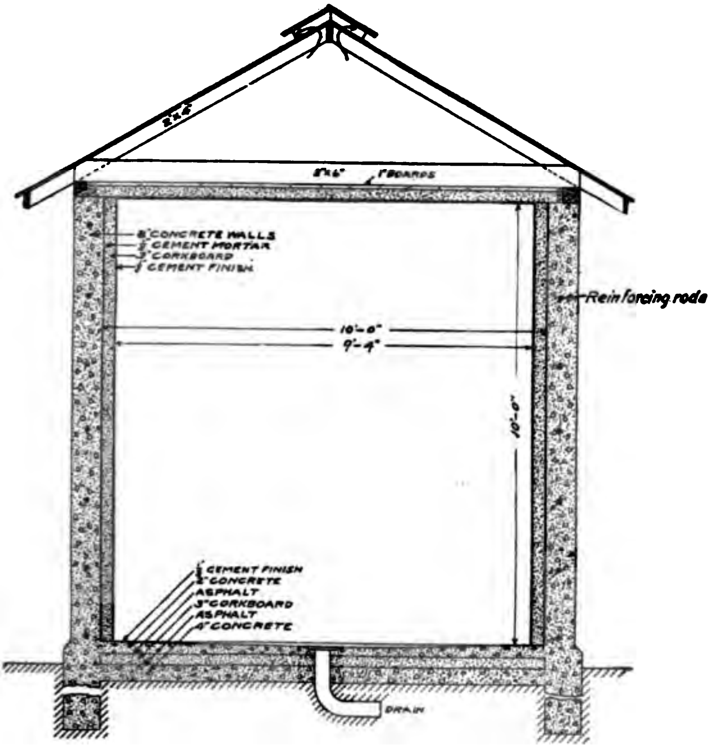


FIG. 22B.—A small concrete ice house. (Section on *A–B* of fig. 22a)

Cork-board insulation is placed on the walls and ceiling in a ½-inch bed of Portland-cement mortar, mixed in the proportion of 1 part cement to 2 parts clean sand. Vertical joints should be broken and all joints made tight. A ½-inch Portland-cement finish is finally applied to the walls and ceiling as well as to the floor.

In many cases it is cheaper to crib the walls to their full height instead of using sectional forms, as a part of the form lumber can be used in the roof and ceiling and the remainder probably can be used to advantage on the farm.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

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No. 1C

FARMERS' BULLETIN 1078
UNITED STATES DEPARTMENT OF AGRICULTURE

Harvesting and Storing Ice on the Farm

WHERE a stream of water or pond is available in the northern section of the United States, natural ice can be harvested and stored at low cost.

Care should be taken that the source of the ice supply is free from pollution and contamination.

Where very cold weather prevails in the winter and ponds and streams are not available, cakes of ice may be frozen in cans.

The space used for storing ice should accommodate about 50 percent more than is actually needed in order to allow for shrinkage.

A cubic foot of ice weighs about 57 pounds. About 45 cubic feet of space should ordinarily be allowed for storing a ton of ice.

Under usual circumstances about ½ to 1 ton of ice per cow for cooling cream or from 1½ to 2 tons for cooling milk is needed annually on a dairy farm.

This bulletin supersedes Farmers' Bulletin 623, Ice Houses and the Use of Ice on the Dairy Farm.

Washington, D.C. Issued January 1920; revised August 1933

HARVESTING AND STORING ICE ON THE FARM

By JOHN T. BOWEN, *senior electrical engineer, Division of Plans and Service, Bureau of Agricultural Engineering*

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SOURCES OF ICE

WATER for the ice supply should be investigated to make sure that it is free from contamination or pollution. Ponds and sluggish streams usually have grass and weeds growing in them and ice harvested from them may contain decayed vegetable matter, which is always objectionable and may be injurious to health. Such bodies of water should, therefore, be thoroughly cleared of such growth before cold weather. Green spawn and algae may be destroyed by the use of copper sulphate (blue vitriol). The crystals can be placed in a cloth bag which is hung on the end of a pole and trailed through the water until all the crystals are dissolved. One or two treatments during the summer at the rate of 1 pound of copper sulphate to 13,000 cubic feet of water will be sufficient to keep down such growths.

Streams or lakes are often polluted by sewage or other impurities that it is impossible to eliminate. A pure ice supply is especially important when the ice is to be used directly in beverages or other foods.

Throughout a considerable area of the United States natural ice is formed during the winter in sufficient quantity to warrant harvesting and storing it (fig. 1). In many areas of this region there are lakes, ponds, and streams from which ice can be harvested, while in other areas it is necessary to create artificially a body of water suitable for producing ice. This may be done either by diverting a stream into an excavation or by constructing dams across low areas. When it is necessary to construct artificial ponds the surface area is usually limited and several cuttings are ordinarily necessary to obtain the quantity of ice needed (figs. 2 and 3).

When cold weather prevails for several weeks at a time and the supply of pure water is limited, ice may be frozen in metal cans or special paper bags. The cans may be made in any convenient size by a local tinsmith and should be of galvanized iron reinforced at top and bottom with iron strips. The bottom is made smaller than the top, to make the removal of the ice easier. The cans are placed near the water supply, filled with water, and left exposed to the weather. A shell of ice soon freezes around the inner surface, and when the shell is from 1½ to 2 inches thick hot water is poured over the outside of the can and the shell removed. A hole is broken through the top of the shell and most of the water inside is poured out. As the freezing progresses water is poured into the shell a little at a time until a solid block of ice is produced. Under this method only a few cans are required, and this fact keeps the cost low.

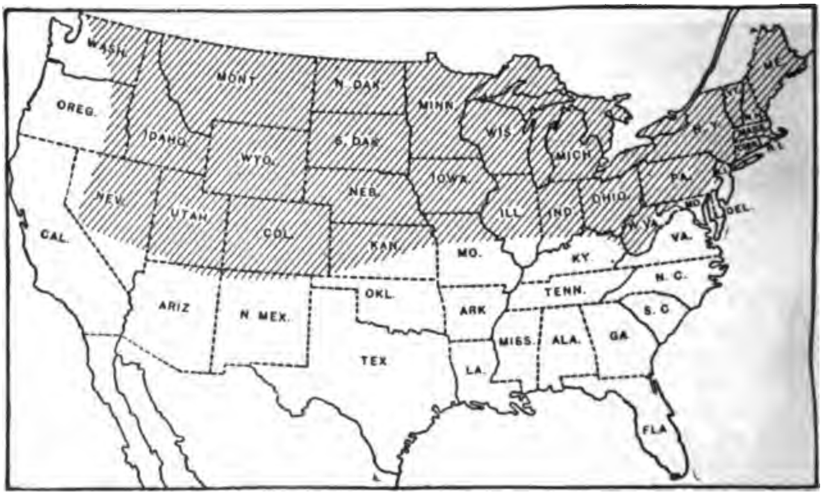

FIGURE 1.—Map of the United States, showing region in which natural ice may be harvested in normal winters.

Nearly the same method is employed in freezing water in special paper bags, although the bags do not last so long as the cans. The advantage of the bags over the metal cans is mainly their cheapness, for they are not so convenient to handle.

Another method that can be used in very cold regions is to run water into the ice house and let a layer freeze. This is done by first constructing a dam of snow around the floor of the house 10 or 12 inches inside the walls in order to allow sawdust insulation next to the walls. The interior of the house is then flooded with a few inches of water, which soon freezes, the procedure being repeated until the house is filled with ice. The ice is then covered with sawdust and the house closed up until the ice is needed. A great disadvantage of this method is that in order to remove ice it must be cut or chopped out with an ax, which results in uneven and irregular pieces and considerable waste of ice.

Floe ice is another source of natural ice. It is obtained in the spring when large pieces of ice float down from the headwaters of streams and rivers. This ice is always broken up into irregular pieces and is not so easily handled and packed as that which is cut in regular shape.

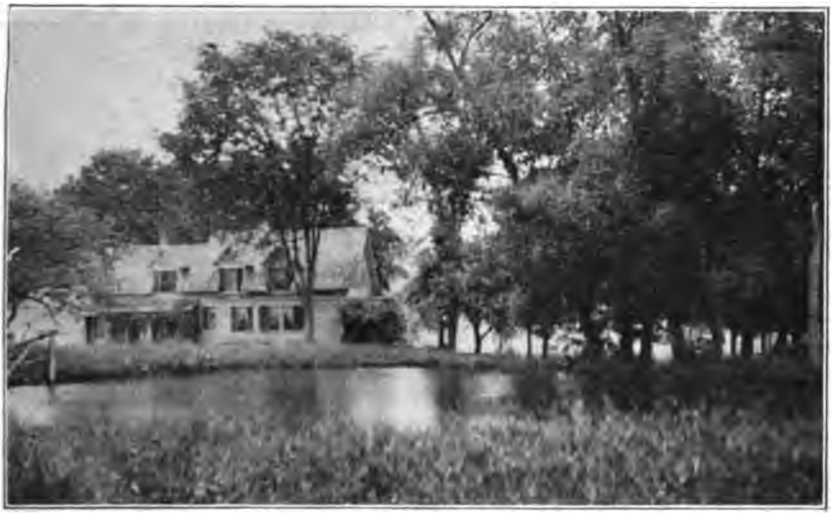

FIGURE 2.—Artificial pond in yard.

QUANTITY OF ICE REQUIRED FOR A DAIRY FARM

The quantity of ice needed for a dairy farm depends on its location, number of cows milked, and methods of handling the product. In the Northern States it has been found that with a moderately good ice house, where the shrinkage from melting is not more than 30 percent, half a ton of ice per cow is sufficient to cool the cream and hold it at a low temperature for delivery 2 or 3 times a week. It must be understood, however, that suitable cooling tanks are neces-

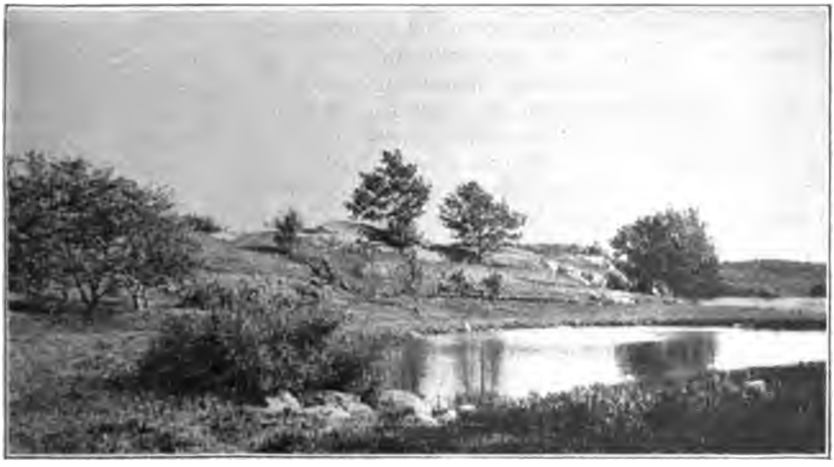

FIGURE 3.—Natural pond.

sary under this estimate. The half-ton-per-cow estimate for ice to be stored allows for a reasonable waste and also for ordinary household use. If whole milk is to be cooled, the quantity of ice stored must be increased to 1½ tons per cow in the North and 2 tons per cow in the South. To meet the needs of the average family on a general farm it will be necessary to store about 5 tons.

HARVESTING ICE

SIZE OF ICE FIELD

When the field is of sufficient size to fill the ice house at a single cutting, the thickness and quality of the ice are more nearly uniform and preparation for cutting and harvesting need be made but once. In many instances, however, the pond or stream is so small that it is necessary to wait for a second crop in order to fill the ice house. The number of square feet of surface required per ton with ice of different thicknesses is shown in table 1.

Table 1.—*Number of cakes of various thicknesses required per ton of ice*

[Cake 22 inches square]

Thickness of ice (Inches)	Number of cakes required per ton	Cutting space required per ton	Thickness of ice (Inches)	Number of cakes required per ton	Cutting space required per ton
		Square feet			*Square feet*
4	31.3	105.4	14	8.9	30.1
6	20.9	70.2	16	7.8	26.3
8	15.6	52.6	18	6.9	23.4
10	12.5	42.1	20	6.3	21.1
12	10.4	35.1	22	5.7	19.1

REMOVING SNOW FROM SURFACE

Where it is not advisable to wet the surface of the ice field and thus hasten the freezing, the snow should be scraped from the surface of the ice, since snow acts as insulating material and retards freezing. If the ice is thick enough to bear the weight of a horse the snow may be removed easily with a scraper, such as is shown in figures 4 and 5. On small ponds the snow may be scraped on to the shore, but on large fields, especially if the snow is deep, it is impracticable to scrape it entirely off the fields and it must be piled in windrows. These windrows, of course, occupy considerable space, so that it is necessary to allow for an increased area of ice.

The distance between the windrows depends upon the depth of the snow. It is advisable to run them at right angles to the main channel through which the ice is floated. The area between the windrows then can be cut back any distance from the main channel, whereas if they run parallel to the main channel only that portion of the surface between can be cut before opening another channel. As the weight of the windrows of snow is usually sufficient to make the ice on which it is piled sink beneath the surface of the water, it is advisable, in order to prevent the water from overflowing the cutting surface, to cut a deep groove, or to cut through the ice parallel to and on both sides of the windrows.

WETTING DOWN THE FIELD

Usually snow falls on the ice before it is thick enough to harvest. Since the weight of the snow has a tendency to sink the ice, advantage is sometimes taken of the layer of snow in forming ice. Holes are made in the ice, and water is allowed to rise through the openings and flood the surface. If the weather is very cold the mixture of snow and water quickly freezes and increases the thickness of the ice.

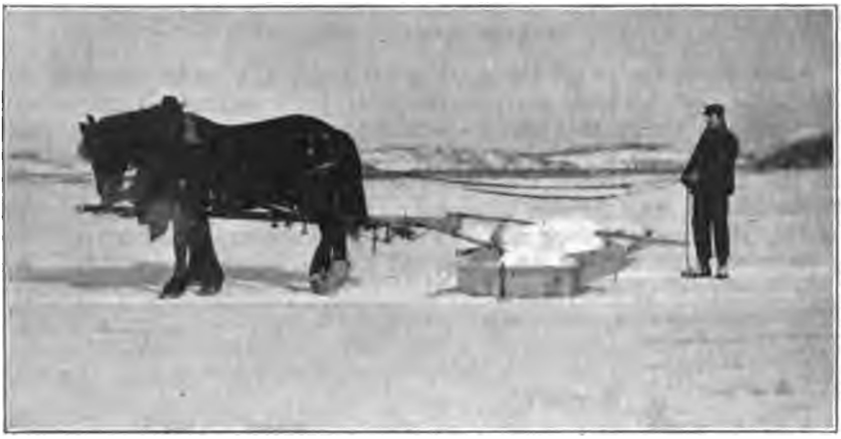

FIGURE 4.—Scraping snow from ice field.

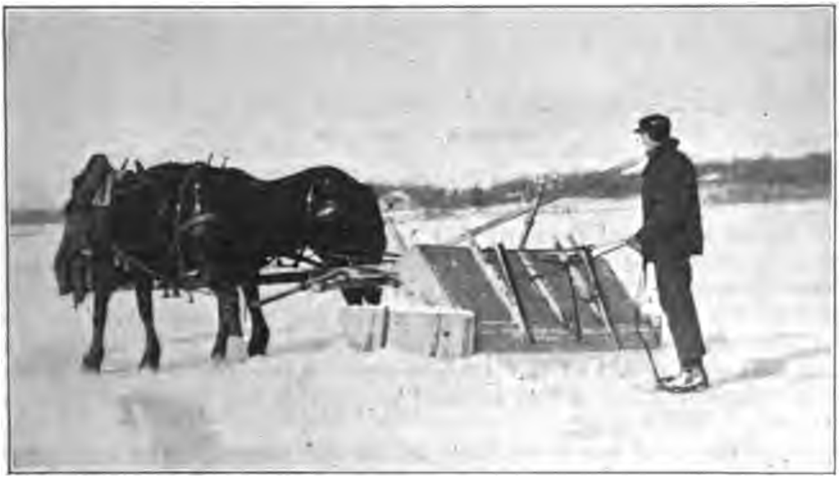

FIGURE 5.—Dumping snow from scraper.

The surface should not be flooded, however, unless the weather is cold enough to freeze the melted snow solid. If only the top surface of the snow freezes, a crust forms which makes scraping difficult and injures the quality of the ice. In that case it becomes necessary to plane or scrape the crust of snow from the ice. The location and size of the holes for wetting down the surface should be planned so that the entire surface is completely covered with water. Ordinarily this is accomplished by small holes 1 or 2 inches in diameter and from 6 to 8 feet apart.

LAYING OFF THE FIELD

After the snow is off the ice the field is ready to be marked for cutting. The marking must be done carefully so that all cakes will be rectangular, as this shape facilitates economical handling and packing in the ice house. If a proper beginning is made in marking off the field, no trouble will be experienced; but if not, subsequent cuttings will be difficult. Success in marking depends largely on getting the first line straight. This may be accomplished by placing a stake at each end of the proposed line to serve as a guide. An ordinary board about 14 feet long is then alined with the two stakes and the cutting tool or hand plow run along its edge, after which the board is pushed forward and again alined with the two stakes. This is continued until the entire distance between the stakes has been covered. Another way is to stretch a line between the stakes and do the marking with a hand plow, but this method is not so satisfactory, because the hand plow cannot be run in so straight a line without the aid of the straightedge. After the first line is cut to a sufficient depth it can be used as a guide for the horse marker (fig. 6), if one is used.

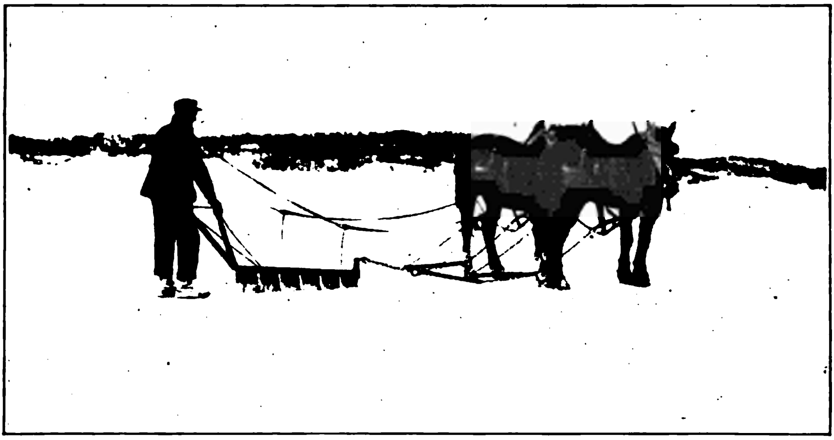

FIGURE 6.—Plowing ice.

After the field has been lined off in one direction the crosslines should be made. Care should be taken to have the crosslines at right angles to those first drawn; this is accomplished by the use of a square. A square suitable for the purpose can be made easily. First nail the ends of two boards together with a single nail. Measure a distance of 8 feet on the outer edge of one board and 6 feet on the outer edge of the other, then nail a third board diagonally across the two, adjusting it until the two marks are exactly 10 feet apart on a straight line. The boards should then be nailed together securely, forming the desired square as shown in figure 7. If the first crossline is drawn with care, it is easy to draw the remaining lines parallel.

SIZE OF CAKES

The size of the cakes depends to some extent on the thickness of the ice, as well as upon tools available for harvesting, but in any case it is important to have all the cakes of the same size. In order to simplify the handling and packing many farmers, especially those who harvest a comparatively small quantity of ice, cut the cakes 22 inches square, a size that is easily handled with a limited amount of equipment. Table 1 gives the number of cakes 22 inches square and of different thicknesses required for each ton of ice.

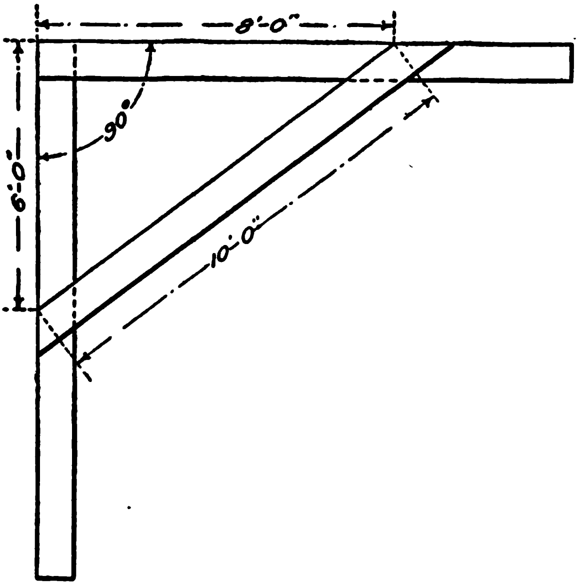

FIGURE 7.—Detail of square for marking off ice field.

From floe ice, which is always broken up, it is of course impracticable to obtain cakes of uniform size; consequently floe ice is gathered and packed as well as possible. The ice ax is used to remove irregular corners and the small pieces are used to fill the holes around the irregular pieces in order to make the whole mass as solid as possible and to reduce to the minimum the quantity of entrapped air.

CUTTING

After the field has been marked off, a strip of ice, one block in width (22 inches) and extending from the loading way to the main channel, is cut through and forced under the surface of the surrounding ice. This strip should be sawed somewhat wedge-shaped, wider at the bottom than at the top, thus allowing it to be forced down under the field with ease. The operation is known as "sinking the header" and opens up a small channel the width of the proposed cakes. The channel is widened by cutting another strip to enable the long strips or floats of ice to be floated from the main channel to the bank or loading way.

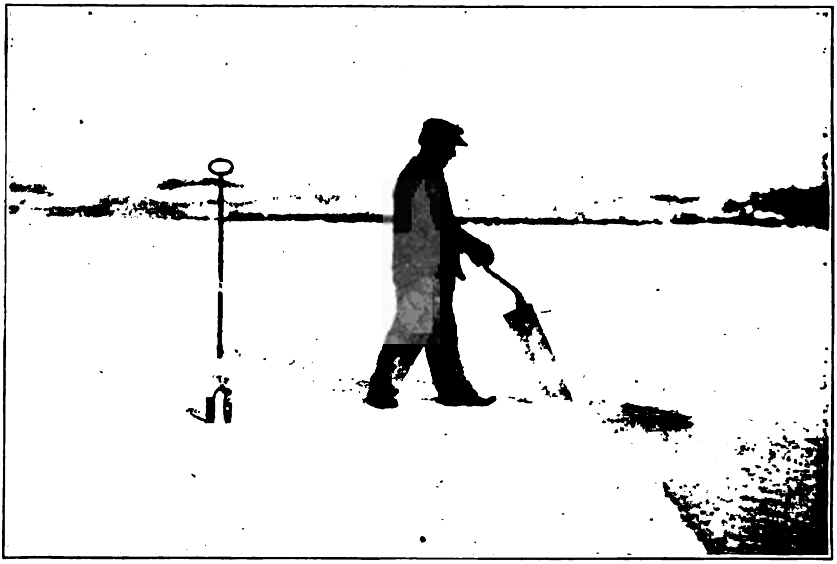

FIGURE 8.—Sawing out floats.

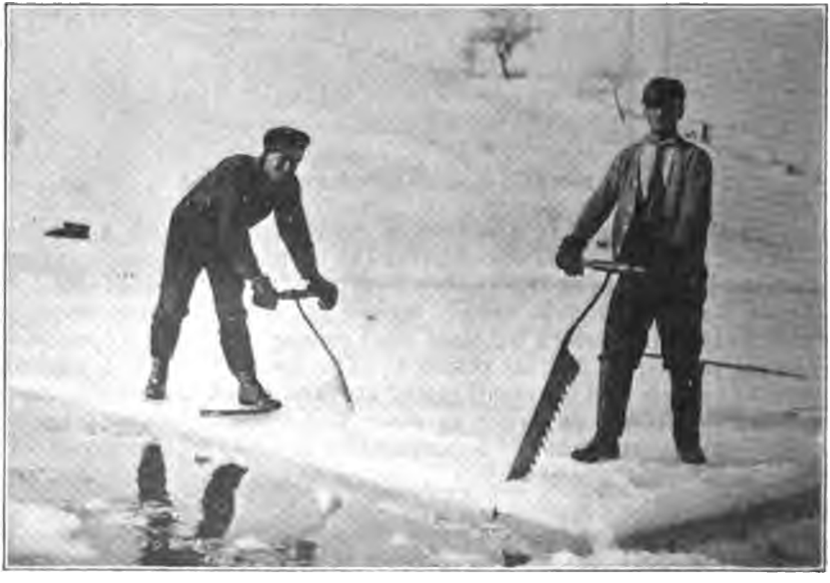

FIGURE 9.—Cutting the ice.

The strips of ice are then pushed with an ice hook along the channel to the bank or loading way, where they are sawed or chopped into cakes (figs. 8, 9, and 10, and cover). The narrow channel, cut at right angles to the main channel, has the advantage of allowing the operator to get closer to the cakes and to handle them more easily. At the end of the narrow channel there should be an inclined track or loading way up which the cakes are drawn either by hand or by a horse (figs. 11, 12, and 13). This track may lead directly into the ice house or to a platform from which the cakes are loaded upon a wagon or sled.

The cakes should not be cut completely through, but should be grooved 2 or 3 inches deep with the plow, floated up the channel, and chopped through with a special tool before being put on the loading way. This practice saves labor and time.

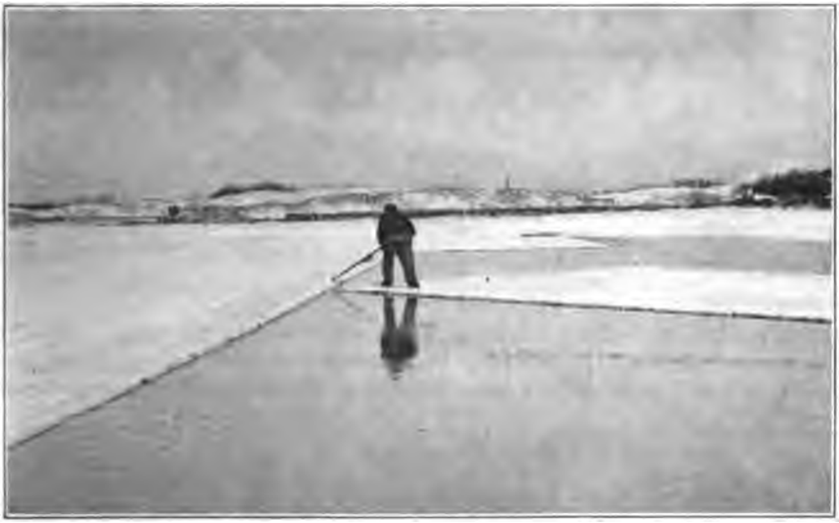

FIGURE 10.—Floating large cakes of ice to shore to be cut into smaller ones.

PACKING

The quantity of ice lost by melting depends partly upon the manner of packing. The cakes should be placed close together so that the mass will be as tight and solid as possible, thus preventing cracks and openings that will allow air to circulate. Perfectly cut rectangular cakes can be closely packed; this emphasizes the importance of special care in cutting to insure cakes of exactly the same size. When they are irregular in size the best plan is to fill up the openings with small pieces of ice. In order to insure close contact between succeeding layers no broken ice should be allowed to remain on top of or to protrude above the ice cakes.

Before ice is placed in the ice house a layer of dry sawdust about a foot thick should be placed in the bottom of the house, the depth of the sawdust being a few inches less in the center than at the outer edge, so that the cakes will have a tendency to slide toward the center instead of toward the walls. The sides of the mass of packed ice should be smooth. Any projecting pieces should be trimmed off before the ice is covered with insulating material. If sawdust or mill shavings are used, a space of at least 12 inches must be left between the sides of the ice stack and the walls of the building. This space is filled with dry sawdust or shavings as the packing in the center proceeds.

In packing small quantities of ice it is a common custom to pour water over the mass of packed ice and allow it to freeze solid before putting the insulating material in place. While this undoubtedly assists in reducing the melting by closing the openings between the cakes, it has the disadvantage of making it more difficult to remove the ice when it is needed. It is then necessary to chop the cakes apart, which wastes considerable ice, so that little is gained in this way.

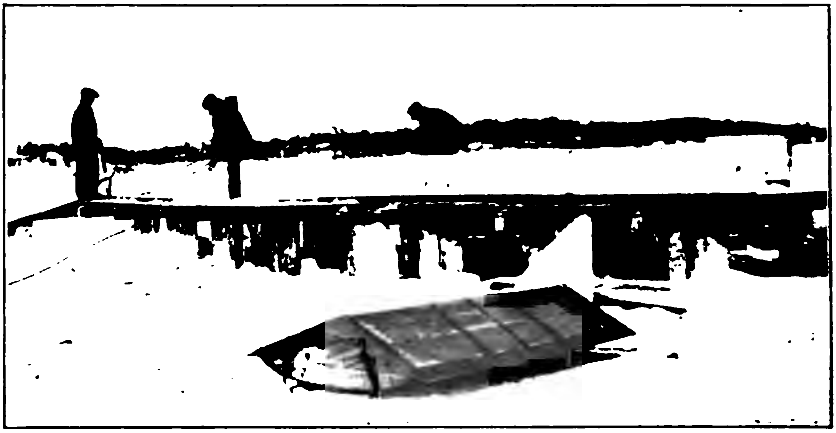

FIGURE 11.—Drawing ice cakes from water to loading platform.

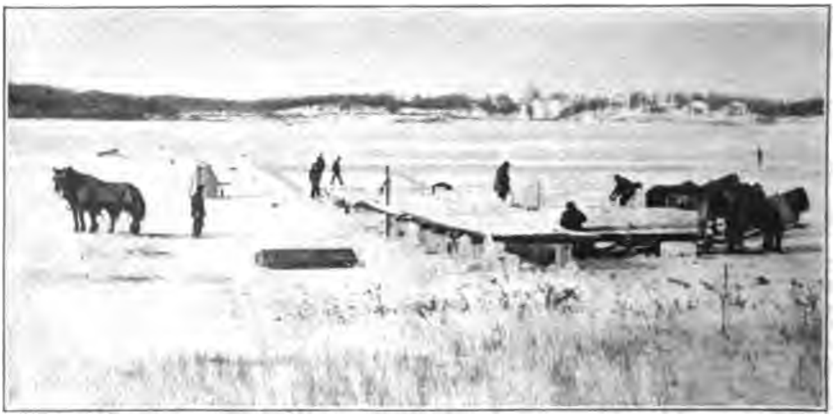

FIGURE 12.—Harvesting and loading ice.

TOOLS REQUIRED

When only a small quantity of ice is to be harvested few tools are required. The following list includes those actually needed: Two ice saws, 1 hand marker, 1 pulley and rope, 2 pairs of ice tongs, 2 ice hooks, 1 pointed bar or splitting fork, and 1 straightedge. Besides these essential tools, additional ones, such as a horse plow and marker, horse scraper, and a calking bar are convenient and will help to expedite the work. The amount of the equipment depends on the quantity of the ice to be cut and on local conditions for handling ice. If the harvesting must be done quickly, to take advantage of the weather, extra equipment will be justified. Neighbors may cooperate advantageously in cutting and storing ice and in owning equipment jointly.

COST OF HARVESTING ICE

The cost of harvesting ice differs with local conditions. It is impossible, therefore, to give an estimated cost that will cover all cases. The ice-harvesting season fortunately comes at a time when there is the least work on the farm for men and teams, and consequently the actual money cost is usually not very great. Investigations have indicated that counting the full value of the men's time, the average cost of cutting ice is about 3 cents for a cake 22 inches square and 14 inches thick, or about 27 cents a ton. Add to this the cost of packing and hauling, and the average cost of a ton of ice is about $1.50, when the ice house is near the source of supply. If the ice house is at a considerable distance the cost of hauling, of course, is increased, and the total cost of storing ice in some instances has amounted to $3 or more a ton.

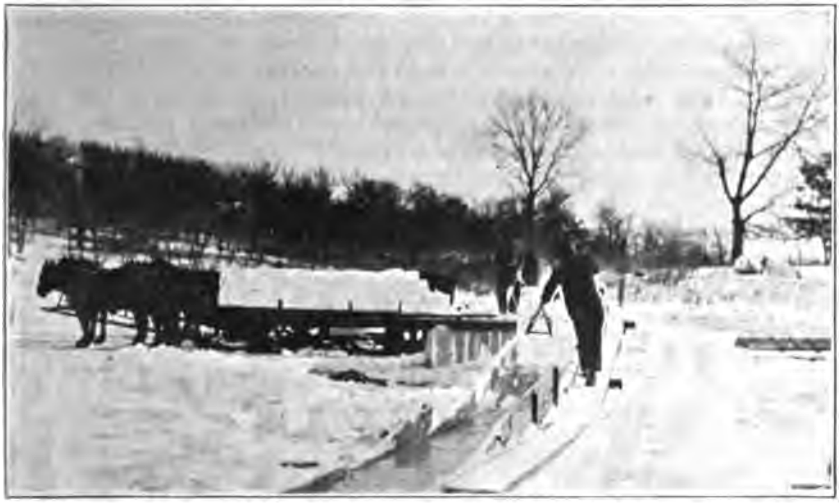

FIGURE 13.—Loading cakes of ice on sleds to be hauled to ice house.

ICE HOUSES

CAPACITY

A cubic foot of ice weighs about 57 pounds, so in storing ice it is customary to allow from 40 to 50 cubic feet per ton for the mass of ice, but the quantity that an ice house of a given size will hold depends upon the manner in which the ice is stored. Generally a cubic foot of an ice house will hold the quantities given below:

	Pounds
Ice thrown in at random, about	30 to 35
Ice thrown in in irregular pieces and broken sufficiently to pack closely	35 to 40
Ice in cakes piled loosely	40 to 45
Ice in cakes piled closely and with very small crevices between cakes	45 to 50

Unless the ice house has permanently insulated walls, at least 12 inches between the ice and the wall of the building and an equal space beneath and above the ice must be allowed for insulation. From this it is possible to calculate readily the quantity of ice that any given house will hold. Thus, allowing 45 cubic feet per ton, an uninsulated ice house 18 by 12 by 10 feet high, allowing 1 foot around the ice for insulation, will hold about 28 tons, while an insulated house of the same size will hold about 48 tons.

Loss by melting is in proportion to the surface area exposed to the air or packing material; hence it is advisable to store ice in the form of a cube, or as nearly so as practicable. Table 2 gives the inside dimensions of insulated houses for various quantities of ice. For uninsulated houses each dimension should be increased 2 feet.

TABLE 2.—*Inside dimensions of insulated ice houses for various quantities of ice*

Quantity of ice	Length	Width	Height	Quantity of ice	Length	Width	Height
Tons	*Feet*	*Feet*	*Feet*	*Tons*	*Feet*	*Feet*	*Feet*
10	10	7	7	30	14	10	10
20	14	8	8	40	18	10	10
25	14	10	8	50	16	12	12

LOCATION

The selection of a site for an ice house is very important. Other conditions being suitable, the ice house on a dairy farm should be placed as near as possible to the milk house, in order to reduce the labor of handling ice and to encourage its more liberal use. On a general farm the ice house should be located near the residence. To facilitate drainage the ground on which the ice house stands should be porous and slope from the building. Advantage may be taken of hills, trees, or buildings, which often afford protection from hot winds and direct rays of the sun, thus saving ice.

TYPE OF CONSTRUCTION

The construction of the ice house depends to a great extent upon local conditions, the size of the house, and the difficulty of obtaining ice. These factors help to determine what sum may wisely be spent for such a building. Where ice is expensive or hard to obtain, a better constructed and insulated and therefore more expensive ice house is advisable. Where natural ice can be harvested and stored cheaply, a cheap structure is usually satisfactory and the loss from melting ice is a small consideration.

The cost of harvesting and storing, the interest on the money invested, and repairs and depreciation on the building are to be

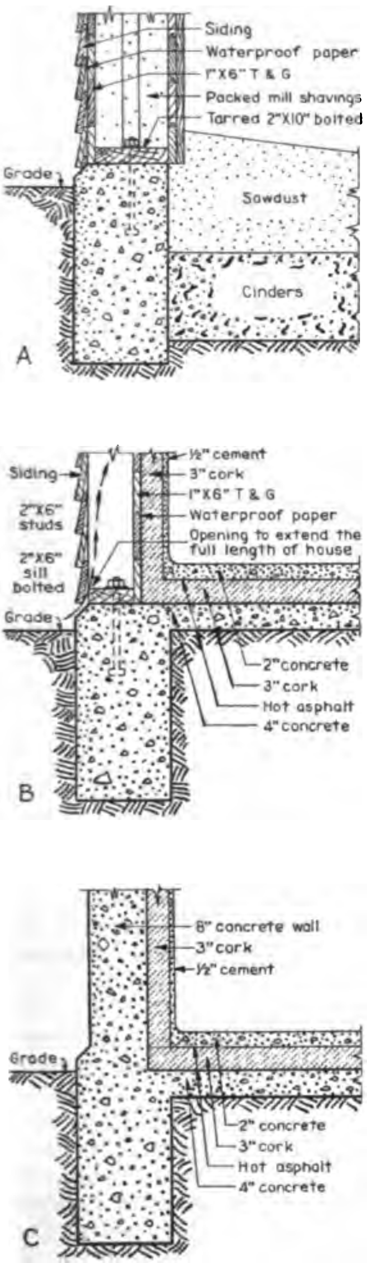

Figure 14.—Details of insulation: *A*, Frame ice house with mill shavings and cinder floor; *B*, frame ice house with commercial insulation and concrete floor; *C*, concrete or masonry ice house with commercial insulation and concrete floor.

considered in relation to the ice loss from melting; and the type of house to be built depends upon these factors. It never pays to build permanently in other than a substantial manner, and careful thought should be given the matter before erecting a cheap structure that may not give adequate service.

INSULATION

The object of insulation is to retard the passage of heat from the exterior to the interior of the building. No material known will entirely prevent the passage of heat, but several, called nonconductors or insulators, offer a high resistance to its passage (fig. 14). The best insulators appear to be those that contain entrapped air in the greatest number of small spaces. Their value also depends upon the density to which they are packed; if too loosely packed they will permit air circulation, if too closely they will cause the conduction of heat to a greater degree. Most of the materials in use give the best results when packed to a density of from 8 to 10 pounds per cubic foot.

Formerly in constructing buildings for the storage of ice or for cold storage, an air space as much as 12 inches wide was provided in the walls. It has been found, however, that an air space 1 inch wide is practically as valuable as one 12 inches wide. Air circulation is useful between the insulated ceiling and the roof of the ice house, for there it tends to break up the heat radiation through the roof. No openings in the ice chamber permitting entrance or exit of air, especially at or near the ground line, should be allowed in a building where ice is stored, as the cold currents of air tend to filter to the outside. If the walls and foundations are kept absolutely tight at the bottom an opening at the top has little effect, because the warm air entering remains at the top of the room. When ice is to be removed from the house the door should be kept open as short a time as possible, and if a covering material, such as sawdust, is used, it is important to replace it after the ice has been removed. In a properly insulated ice house no covering for the ice is needed. It is merely packed on the floor of the room and depends on the insulated walls for protection from the outside heat.

In the cheaper ice houses, which do not have insulated walls, sawdust or mill shavings are commonly used to protect the ice. They are applied directly to the bottom, sides, and top of the ice stack. A layer of such material about 1 foot deep should be placed on the floor and the ice stacked upon it, a layer at a time. Ice will melt rapidly if placed directly on the ground, because moist ground is a fairly good conductor of heat.

For insulating the walls of frame buildings, planing-mill shavings are better than sawdust, because they are elastic, do not settle so readily, do not absorb moisture so rapidly, and are free from dirt, bark, and chips. When used as filling for walls or ceiling they should be well packed into place to prevent settling. Sawdust has been in common use for insulating because it usually could be obtained easily and at little or no cost. It has the disadvantage, however, of nearly always being damp, a condition which destroys its insulating value and favors the growth of mold and rot both in the sawdust and in the walls of the building. The rotting generates heat and also causes the sawdust to settle, thus leaving open spaces which further decrease the insulation. When sawdust is to be used it should be dried thoroughly before it is put into place. It can be dried by spreading it out about 6 inches deep and exposing it to the air and sunshine for a few days. Stirring will hasten the drying.

There are several kinds of commercial insulating material which are much more effective than either sawdust or shavings, and while their first cost is somewhat greater, in the end they are usually cheaper. Their insulating value is uniform, and moisture has little effect on them. In addition they are practically fireproof, occupy little space, and retain their efficiency a long time. Experienced workmen must install such material if best results are to be obtained.

DRAINAGE

Good drainage is essential for satisfactory ice storage. In houses where the floor is below the ground level enough drainage can usually be obtained through the soil if it is porous. With a clay soil it may be necessary to excavate a foot or two and fill the excavation with gravel or cinders or to place a tile drain under the floor. The drain should be trapped or sealed outside the walls to prevent warm air from entering the building through the floor. Dry soil affords better insulation than wet earth; hence it is advisable, where subsurface water is likely to keep the ground under the house damp, to lay a tile drain around the outside of the foundation walls. (Fig. 15.) In place of the tile a drain may be made of crushed rock and gravel, packed in a manner similar to that described under ice pits (p. 22).

As in the case of pits, the floor of the ice house should slope toward the center to keep the ice in a compact mass and to carry the water to the drain.

VENTILATION

Whatever the construction of the building, there is certain to be more or less melting that will cause moisture to appear on the walls and ceiling. If the building is of wood, the moisture is absorbed by the wood, and decay follows; wooden houses therefore should have a means of ventilation which can be controlled. A house equipped with commercial insulating material, covered inside with a cement finish, needs no ventilators from the ice chamber, but the building should be so constructed as to afford a circulation of air through the outer walls (fig. 14, B) and from the eaves to the ventilator on the roof (fig. 20). The resulting air currents tend to break up the heat radiation through the walls and roof.

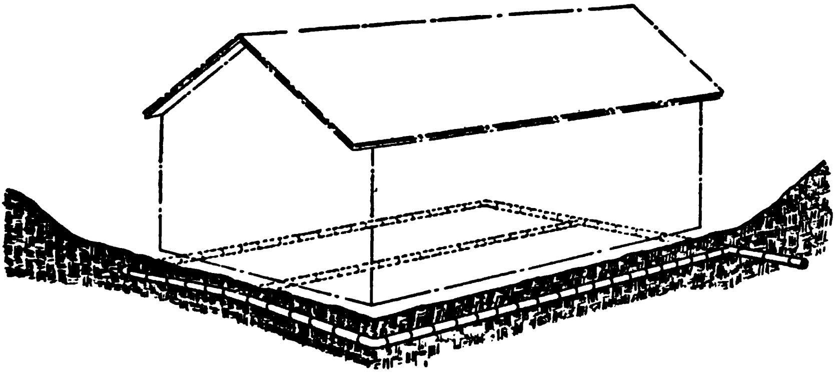

FIGURE 15.—Tile drain and foundation walls.

WATERPROOFING

It is of great importance that brick, concrete, and wooden buildings be waterproofed on the inside. Brick and concrete may readily be waterproofed by painting the walls with a suitable paint or waterproofing compound, such as preparations of paraffin and asphalt. Frequently paraffin and asphalt are melted and applied hot, in which case heating the walls facilitates their application. Several water-excluding paints and compounds for preserving wood are on the market. Creosote is considered one of the best preservatives, provided the wood is thoroughly impregnated with it, but on account of its odor it is objectionable in houses where food products are stored.

GENERAL SPECIFICATIONS FOR VARIOUS UNINSULATED TYPES OF ICE HOUSES

POST ICE HOUSE

Floor.—Consists of 12 inches of coarse gravel tamped into place as shown in figure 16.

Walls.—Posts are set up about 3 feet from center to center as indicated in figure 16, extending 3 feet into the ground and capped by a plate made of two pieces of 2-by-4-inch material; the inside is sheathed with 1-inch boards. The posts and boards below the ground should be treated with some preserving compound.[1]

Ceiling.—No ceiling is provided.

Roof.—The type of roof used is shown in figure 16.

Doors.—A door may be provided by cutting out the boards between two posts in the end of the house and closing the opening by placing short boards across on the inside and packing sawdust against them to keep them in place.

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[1] For information on this process see Farmers' Bulletin 744, entitled "The Preservative Treatment of Farm Timbers."

Drainage.—Drainage is obtained by sloping the floor of the house so that the water will run to the center. A ditch should be dug as indicated, and filled with gravel and small stones. This ditch should empty outside at a point where there is sufficient fall to carry the water away. A draintile may be provided, as shown in figure 17. It should be properly trapped to prevent the entrance of warm air.

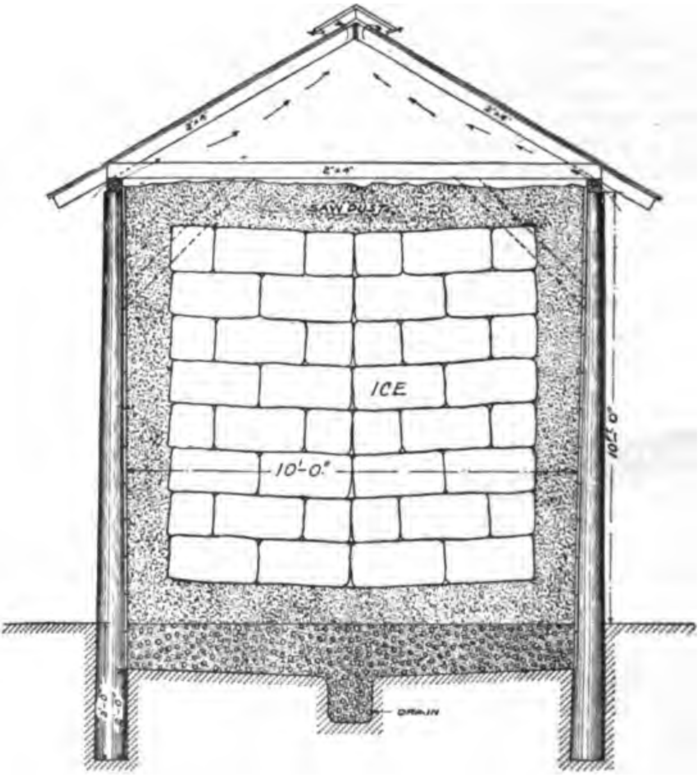


FIGURE 16.—Post ice house, uninsulated.

FRAME ICE HOUSE

Floor.—Consists of 12 inches of coarse gravel tamped into place, as shown in figure 17.

Walls.—On a 2-by-10-inch mudsill 6-by-6-inch sills are placed with 2-by-4-inch studs spaced about 2 feet center to center; on the inside of the studs 1-inch boards are nailed. The studding is capped as indicated. Both mudsills and sills should be treated with creosote.

Ceiling.—No ceiling is provided.

Roof.—The type of roof used is shown in figure 17.

Doors.—A door may be provided as suggested for the post ice house.

Drainage.—Drainage is provided by sloping the floor toward the center. Either a ditch such as is described for the post ice house or a draintile may be used to carry off the water. The same requirements are necessary as in the post ice house.

OPEN-TYPE ICE HOUSE

Figure 18 illustrates a small frame ice house such as is recommended by the Rochester (N.Y.) Health Board.

Floor.—Should consist of 12 inches of crushed stone or coarse gravel well tamped into place.

Walls.—The walls consist of 2 by 4 inch studs spaced about 2 feet center to center and erected on 6 by 8 inch sills. On the inner side of the studs are

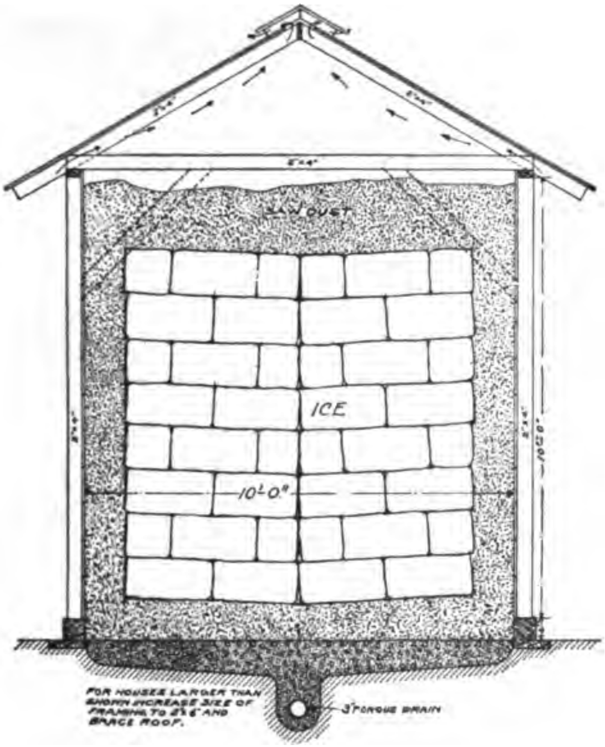

2"x4"
2"x4"
2"x4"
SAW DUST
ICE
10'-0"
2"x4"
2"x4"
10'-0"
FOR HOUSES LARGER THAN SHOWN INCREASE SIZE OF FRAMING TO 2"x6" AND BRACE ROOF.
3" TONGUE DRAIN

Figure 17.—Frame ice house, uninsulated.

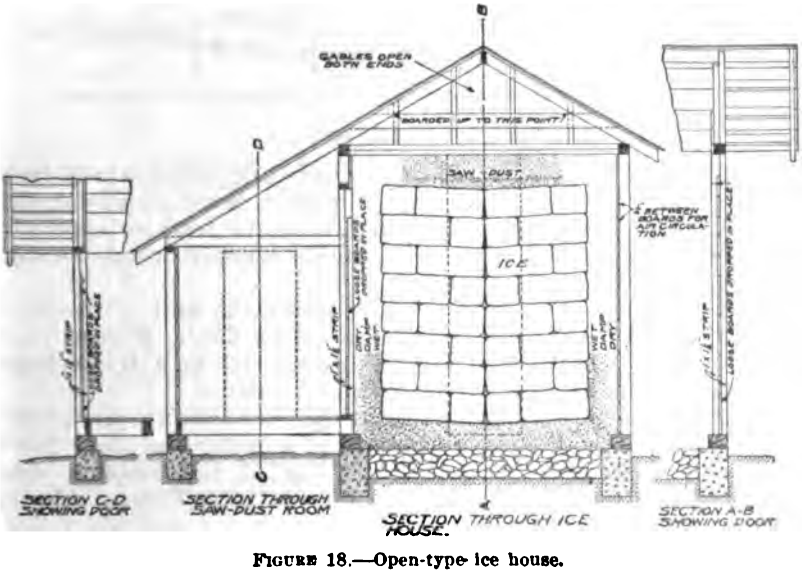


Figure 18.—Open-type ice house.

placed 1-inch rough boards with a ¼-inch space between. The object of the open construction is to dry out the outer layers of sawdust around the ice.

Ceiling.—No ceiling is provided. The gables are left open to permit circulation of air over the ice.

Doors.—Doors are constructed as shown and consist of loose boards dropped into place.

Drainage.—Drainage is provided by sloping the floor toward the center of the house. If the house is built on porous soil no drain will be needed; otherwise one of the forms of drainage described for the post ice house should be used.

Roof.—The roof is constructed as shown in figure 20 with an overhang of about 2 feet to prevent rain from blowing in on top of the ice.

Sawdust room.—A storage room for sawdust should be constructed as shown in figure 18.

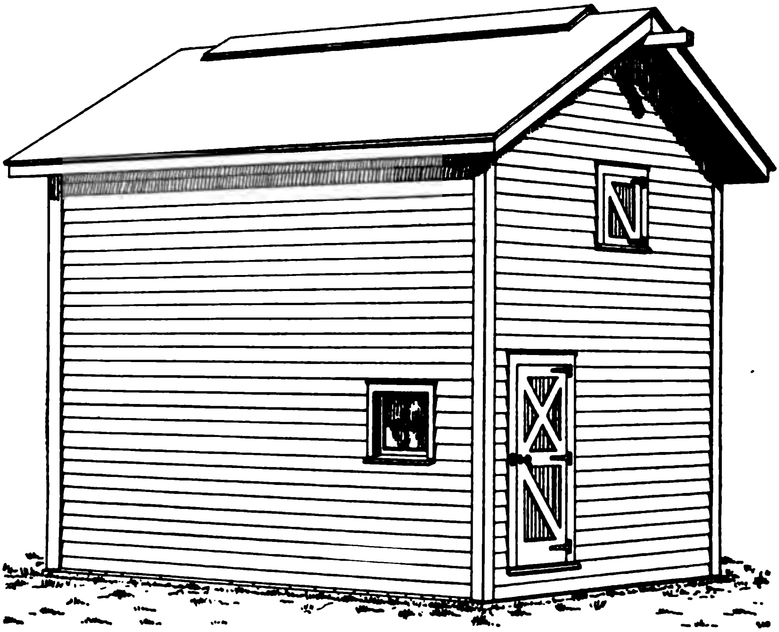


FIGURE 19.—Wooden ice house insulated with sawdust or mill shavings.

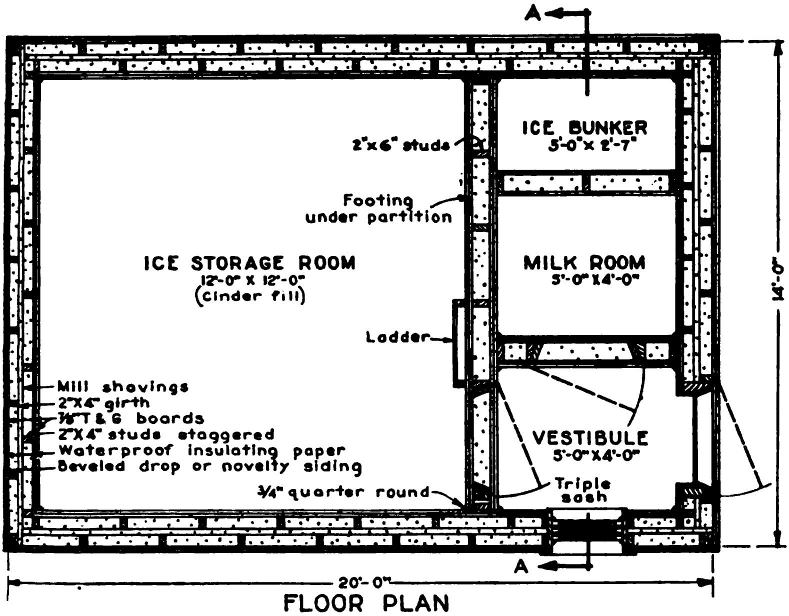
PERMANENT ICE HOUSES

A permanent ice house should be carefully and substantially built. Figures 19 and 20 illustrate the type of wooden house usually erected on farms. The vestibule and cooling room are features especially desirable on dairy farms but can be readily omitted where ice storage is the only objective.

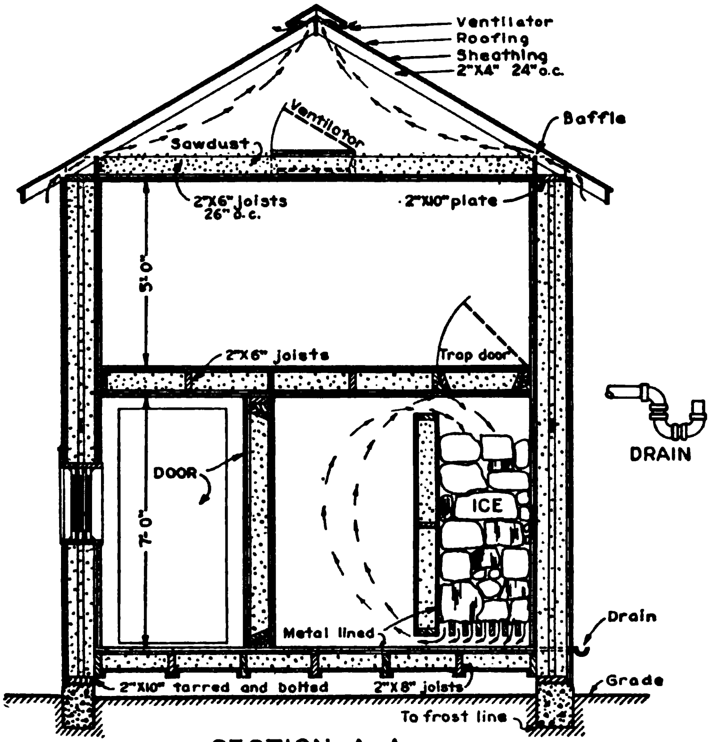
Figure 14, A shows the method of building the wall of the house shown in Figure 19 so as to provide a cinder floor. Figure 14, B shows the use of commercial insulating material in a frame house while figure 14, C shows its use on masonry walls.

Screened openings should be built in the foundation walls around the vestibule and milk room to permit ventilating the space below the wood floor in order to prevent rotting of the timbers; these openings should not be built through the partition footing into the ice-storage compartment.

Foundations should be of stone or concrete mixed 1 part cement, 3 parts sand, and 5 parts gravel, and having depth sufficient to insure a solid bearing and protection from heaving caused by frost.



FLOOR PLAN



SECTION A-A

Figure 20.—Plan and section of house shown in figure 19.

When the floor is not to be paved with concrete, cinders should be used in preference to sand, gravel, or crushed rock to cover the ground area of the building. The cinders should be placed in a 12-inch layer and well tamped.

Ceilings should be built as shown in figure 20 but it is not desirable to provide the ventilators opening into the roof space if commercial insulating material is employed.

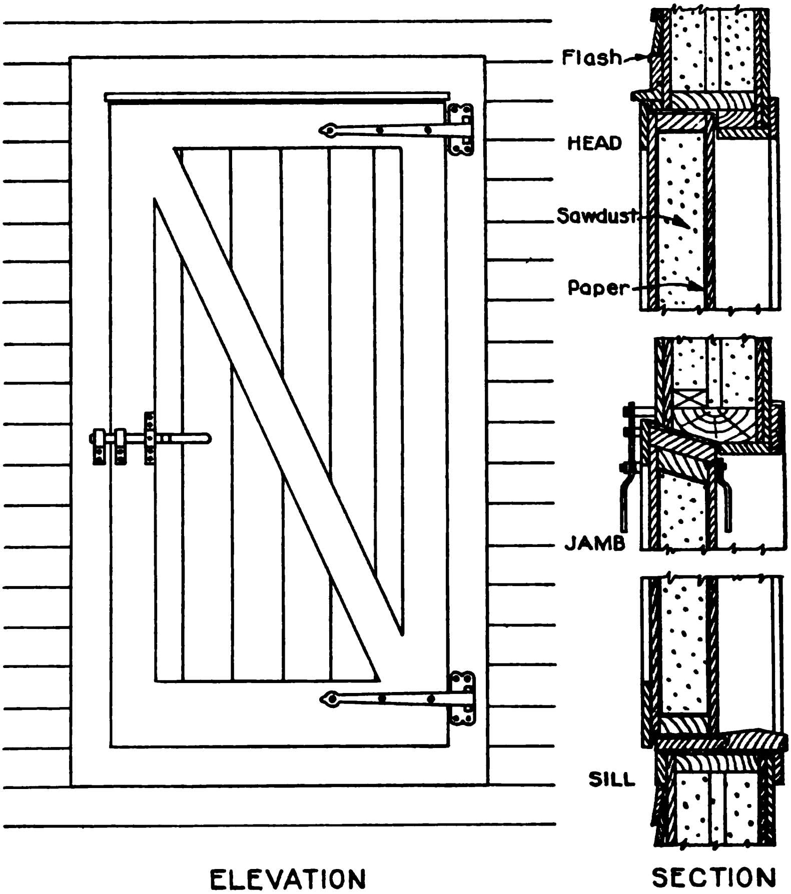


FIGURE 21.—Detail of service door.

Ordinary building paper is not satisfactory for use in ice houses—only heavy waterproof insulating paper should be used. Double thickness of paper is required in all cases, each layer lapping 6 inches over the preceding one. The layers should extend around all corners and breaks should be carefully sealed.

Doors should be constructed as shown in figure 21 and should be of good quality lumber. Commercial doors can be purchased at a reasonable price and probably will be more satisfactory than those made by a carpenter inexperienced in this kind of work. Continuous doors (fig. 22) facilitate filling and are built in addition to a service door. Where the milk room is a feature or when frequent entrance to the ice house is required a service door is very necessary.

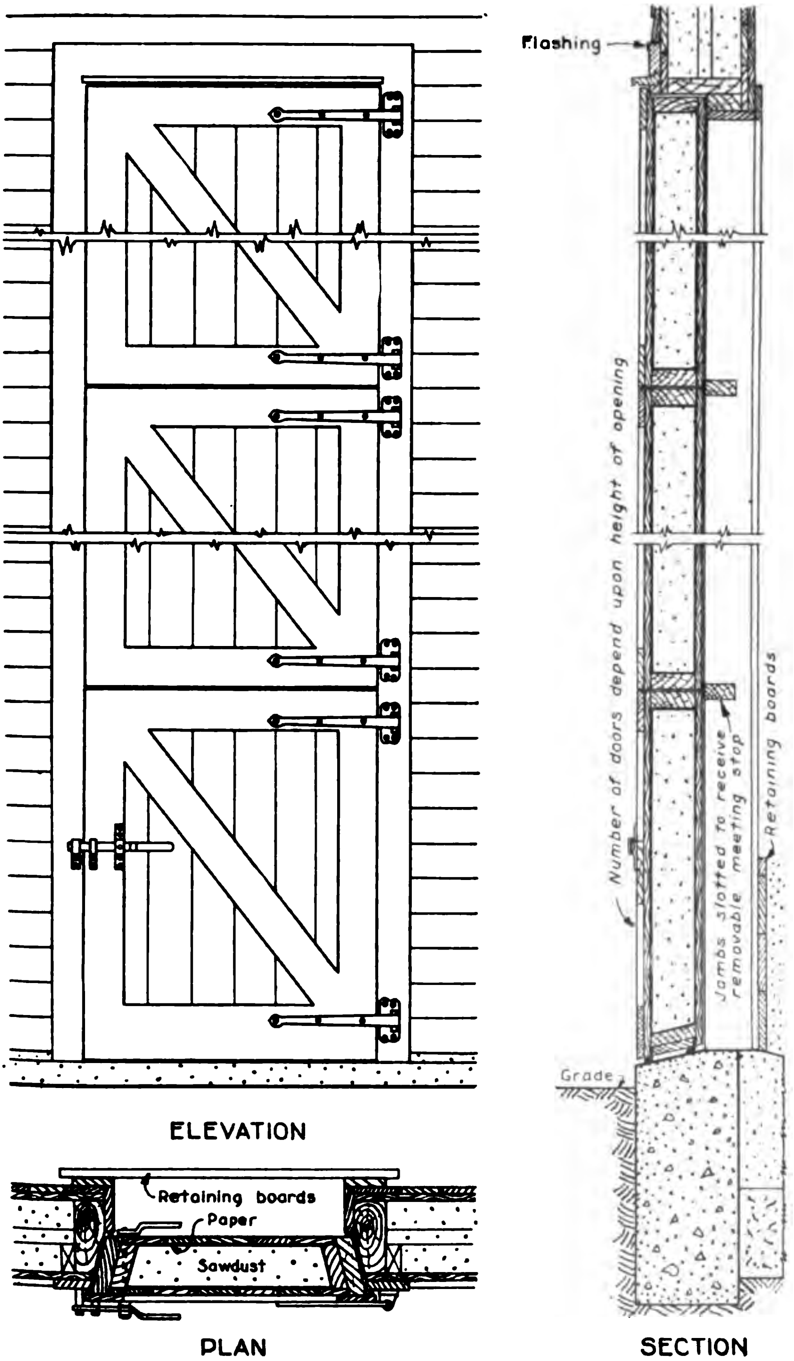
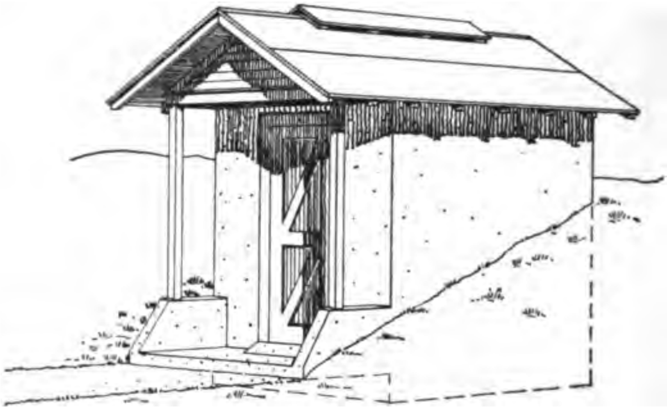

ELEVATION
Retaining boards
Paper
Sawdust
PLAN
Flashing
Number of doors depend upon height of opening
Jambs slotted to receive removable meeting stop
Retaining boards
Grade
SECTION

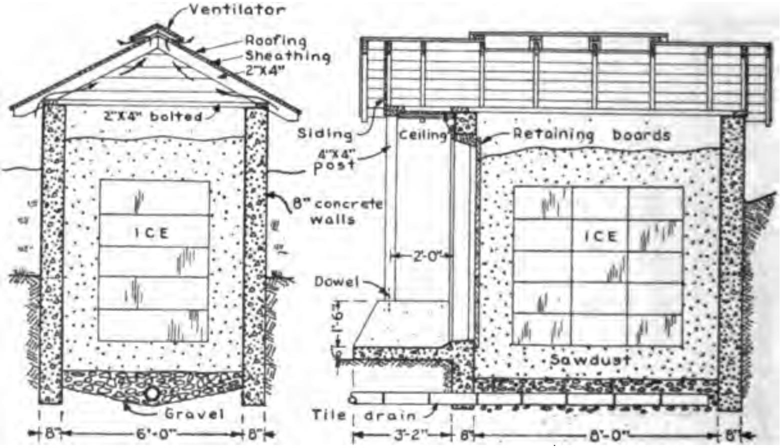
FIGURE 22.—Continuous door.

SMALL ICE HOUSES

Where it is desirable to store several tons of natural ice for family use or to hold a supply of manufactured ice for a short period in order to save frequent trips to the factory, the structure shown in figure 23 will be found convenient. The details previously given regarding building ice houses should be followed in erecting such a house. The concrete mixture[2] should be: 1 part cement, 2 parts sand, and 4 parts gravel or broken stone.



PERSPECTIVE



CROSS SECTION LONGITUDINAL SECTION

FIGURE 23.—Small ice house.

ICE PITS

If a suitable, well-drained location is available and only a small quantity of ice is to be stored, a pit may be used to advantage (fig. 24). The site selected should be sloping in order that a drain may be placed under the floor of the pit. This drain may be of tile or may be simply a trench packed with small stones or gravel. If a tile drain is installed, it should be properly trapped to prevent the entrance of warm air into the pit. The trap should be placed outside the building where it will be accessible in case the drain becomes clogged. It may be placed where the drain discharges upon the ground, but as a stoppage may occur between the building and the trap it is better to place it close to the foundation wall. The trap should be of the handhole type with a terra-cotta stopper made air-tight with a light pointing of cement which may easily be removed when necessary. The drain should not be laid near trees, as the tree roots will find their way into it, causing a stoppage in a very short time. Unless adequate drainage is provided the bottom of the pit will be flooded with water from melted ice or from seepage.

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[2] For detailed information on concrete see Farmers' Bulletin 1279, Plain Concrete for Farm Use; and Farmers' Bulletin 1480, Small Concrete Construction on the Farm.

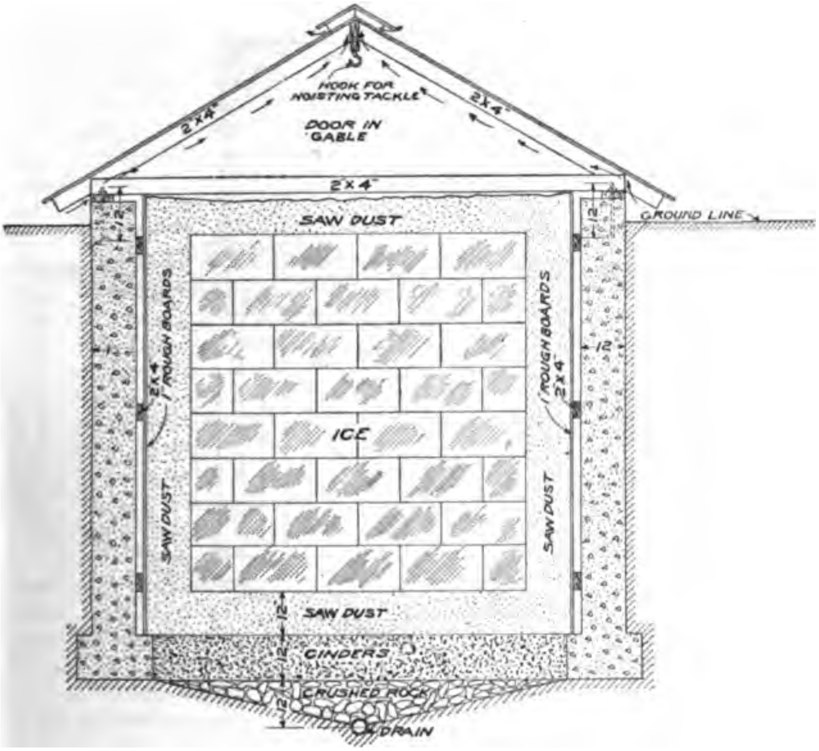

Figure 24.—Ice pit.

The floor of an ice pit should consist of 12 inches of crushed rock or coarse gravel tamped into place, and 12 inches of cinders, also well tamped, on top of the rock or gravel. The walls should be 12 inches thick, made of concrete mixed in the proportion of 1 part of Portland cement to 3 of sand and 5 of crushed stone or gravel. Walls should be waterproofed as suggested on page 15. No ceiling is required, and the roof may be constructed as shown in figure 24. A door in the gable or a hatchway through the roof will be needed.

Drainage inside the pit is provided by sloping the floor toward the center and having the water pass into the tile or gravel drain.

ICE CHEST

Frequently the farmer needs an ice box in which to store household provisions for short periods of time or to hold several cakes of ice as a supply for a small refrigerator. Figure 25 shows the essential points of construction of such a box. The inside dimensions will depend upon the size of box required. A 300-pound cake of ice measures about 11 by 22 by 44 inches. Allowing 4 inches more to facilitate handling the ice, the inside dimensions of a box to hold three cakes will be, assuming the cakes are laid flat, 26 inches wide by 48 inches long by 36 inches deep. If 3 half cakes are piled on top of each other and 1 half cake is stood on edge, there will be space for two cakes of ice and 15 inches at one end for storage shelves. If three 10-gallon cans of milk are to be stored in addition to the ice, a width of 36 inches will be required.

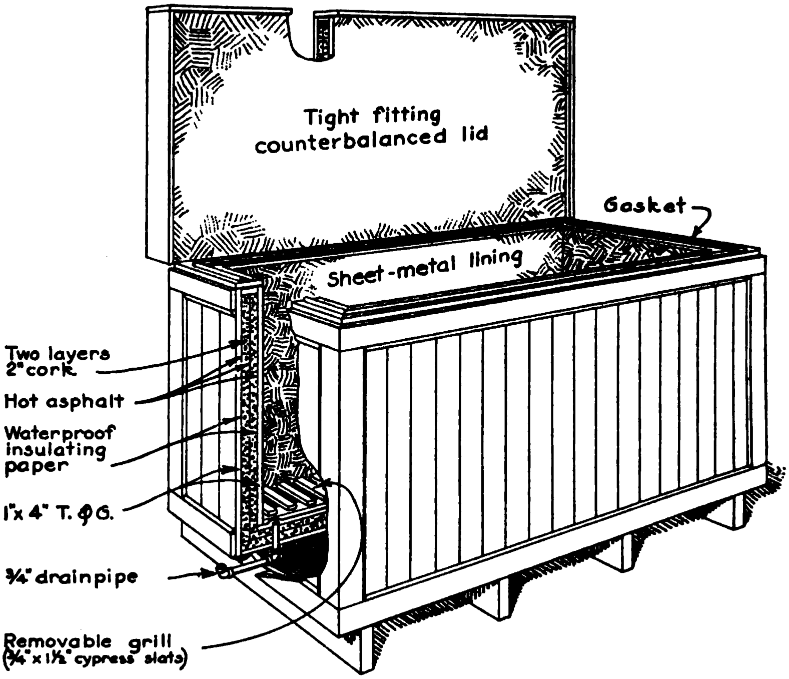
Tight fitting counterbalanced lid
Gasket
Sheet-metal lining
Two layers 2" cork
Hot asphalt
Waterproof insulating paper
1"x 4" T. & G.
¾" drainpipe
Removable grill (¾"x 1½" cypress slats)

FIGURE 25.—Ice chest.

Insulation equivalent to 4 inches of cork board should be provided. Other types of board insulating, or granulated cork, may be used by allowing for their thickness in the space indicated in figure 25 for the 4 inches of cork board. If cork board is used it should be installed in two layers of 2 inches each, care being taken to break all joints. Waterproof insulating paper should be installed as shown, primarily for preventing the entrance of air. The cork board should be covered on the sides with hot asphalt, but no asphalt should be applied to the edges. The drain should be effectively trapped to prevent air entering the box. The box and underside of cover should be lined with galvanized metal, either zinc or copper.

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A 1.9: 1079

LAWS RELATING TO FUR-BEARING ANIMALS, 1919

A SUMMARY OF LAWS IN THE UNITED STATES, CANADA AND NEWFOUNDLAND, RELATING TO TRAPPING OPEN SEASONS, PROPAGATION, AND BOUNTIES

GEORGE A. LAWYER, Chief United States Game Warden, and
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Marten

FARMERS' BULLETIN 1079

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief

Washington, D. C. September, 1919

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1919

AMERICAN TRAPPERS receive yearly in the aggregate many millions of dollars for their fur harvest, which up to the moment they set out to gather it does not cost them a single effort. Recently the supply of peltries has been decreasing at an alarming rate. Raw-fur buyers representing all parts of the country place the decrease at from 25 to 50 per cent during the last 10 years. There are no longer any virgin trapping grounds. Even in Alaska the two most important fur-bearing animals, the beaver and the marten, have become so nearly exterminated that they are now being protected by a close period.

Laws protecting fur-bearing animals are designed to keep a steady flow of peltries coming to market year after year, thereby bringing trappers a reliable income and giving regular employment to thousands of people engaged in dressing skins, manufacturing garments, and distributing them through the various avenues of trade.

A general protest comes from raw-fur buyers against traffic in unprime skins. The losses caused by killing fur animals when their pelts are not prime are enormous. An educational campaign is greatly needed to prevent this waste and to perpetuate our fur-producing resources.

It is hoped that the information contained in this bulletin will be instrumental in promoting judicious and harmonious action in this important matter.

LAWS RELATING TO FUR-BEARING ANIMALS, 1919.

A SUMMARY OF LAWS IN THE UNITED STATES, CANADA, AND NEWFOUNDLAND, RELATING TO TRAPPING, OPEN SEASONS, PROPAGATION, AND BOUNTIES.

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LEGISLATION OF 1919.

Twenty-nine of the 44 States which held legislative sessions this year enacted laws relative to fur-bearing animals. The general tendency was to increase restrictions and afford greater protection to the animals. Laws fixing State seasons on fur animals were enacted in Alabama, Idaho, and South Carolina, and trapping licenses were prescribed in Alabama, Arizona, Idaho, Illinois, Minnesota (residents), Nebraska, Ohio, and South Carolina. Details of the more important new laws are included in the following summaries under States and Provinces.

Alabama.—A general act prescribes a close season on beaver, otter, bear, fox, raccoon, opossum, mink, and muskrat from March 1 to October 31, requires a $10 trapping license, and makes it unlawful to trap on the lands of another without written permission. Other provisions of the act permit a land owner to protect his premises from the depredations of fur animals, and to trap on his own lands during the open season without a license.

Arizona.—Beaver are protected until December 31, 1922; a license (fee, $2.50) is required of persons over 18 years of age to hunt or trap fur or predatory animals, and it is made an offense to disturb or remove the traps of a licensed hunter who is trapping on the public domain or under permission on the lands of another. Fur and predatory animals may be kept, under permit from State game warden, for propagation, exhibition, or sale. Fur and predatory animals are defined as mountain lion, bear, wolf, coyote, civet, and ring-tailed cats, leopard, fox, beaver, otter, badger, fisher, skunk, raccoon, opossum, mink, marten, weasel, muskrat, mole, and wood rat, all of which, except beaver, may be taken at any time.

Arkansas.—The open season on bears is fixed as November 10 to January 15, thus lengthening the season five days. State hunting licenses are required to take bears, and a license (fee, $1.50) is prescribed for each dog used in hunting bears. The export of bears is prohibited, except that a licensed nonresident under affidavit of lawful killing may take out one animal if not for sale.

Connecticut.—The season on raccoon is fixed as October 16 to January 31, instead of October 16 to February 28; and the season on skunks is closed January 31 instead of April 30.

Delaware.—Otter, after being protected at all seasons for several years, may now be taken from December 1 to March 25; the season on raccoon and opossum is closed January 1 instead of February 15; the uniform State open season on muskrat is made from December 1 to March 10.

Idaho.—Licenses are required for trapping fur animals (fees, resident, $5; nonresident, $25; alien, $50). An open season from October 1 to March 31 is fixed for all fur animals except bear—beaver and otter formerly could be taken under a permit from the State warden only when injuring property. Bear and predatory animals, including mountain lion, wolf, coyote, lynx, bobcat, jack rabbit, skunk, and weasel, may be killed at any time. Provision is made for the issuance of permits by the State warden to persons desiring to raise fur animals in captivity.

Illinois.—The period from November 1 to March 15 is prescribed as the open season for fur animals, including foxes, which formerly were unprotected. Possession of green hides is prohibited except during the open season and the first 10 days thereafter. Trapping licenses are required (fees, resident, $1; nonresident, $10.50).

Maine.—A special license (fee, $25) is required to take beaver in such territory as may be opened to beaver trapping by the commissioner. The fee for a general license to trap in unorganized townships is increased from $5 to $10, but bears and bobcats may now be taken without a license. It is unlawful to transport or dispose of a beaver hide unless an official seal of the commissioner has been attached thereto. The bounty on bobcat and Canada lynx is increased from $4 to $10.

Massachusetts.—A close season from January 1 to September 30 is prescribed for raccoon.

Michigan.—The period during which beaver may be taken under a special license is fixed as November 1 to April 15, thus shortening the season one month. The season on otter, mink, fisher, and marten is shortened one month by closing February 15 instead of March 15. October 15 to December 31 is prescribed as the open season on raccoons, and October 16 to April 14 north of Range 20, and December 16 to March 31 south of Range 21, on muskrats instead of the former State season from November 16 to March 14. Badger, beaver, and muskrat are protected at all times in and within 2 miles of any city public park containing over 200 acres of which 150 acres or more is woodland.

Minnesota.—The law relating to fur animals is amended generally in the act revising the game laws. Raccoon, fisher, and marten, formerly unprotected, are included in the list of fur animals for which close seasons are prescribed. The period from December 1 to April 1 is fixed as the open season on mink and muskrat, thus shortening the season two weeks. Protection is removed from black bear. Nonresidents are prohibited from trapping, but residents may trap under a $1 license. The commissioner may issue licenses (fee, $1; bond, $500) to trap a limited number of beaver, and the skins of such beaver when tagged (fee, $3) may be bought, sold, or transported at any time. State bounties, wolf, $7.50; cub wolf, $3, were prescribed.

Missouri.—The period from November 1 to January 31 is fixed as the open season on fur animals instead of December 1 to February 1. A license (fee, $5) is required to breed fur animals.

Montana.—A close season from May 1 to September 14 is prescribed for marten and a special license (fee, $1) is required to trap them.

Nebraska.—Trapping licenses are prescribed (fees, resident, $2; nonresident or alien, $10). The former season of November 1 to February 15 on fur animals is changed to November 20 to March 20 on muskrat, opossum, and otter; September 20 to March 20 on raccoon and skunk (skunk formerly unprotected); and December 1 to January 31, on mink.

New Hampshire.—A special season from November 1 to March 31 is prescribed for muskrats on the Connecticut River.

New Jersey.—It is now unlawful to take skunk, mink, or otter in any manner except by trap. The months of April and May are included in the period during which foxes may be hunted under permit from the board of game commissioners.

New York.—Raccoons may now be taken in Catskill Park from October 1 to March 15 in any manner except by trapping, and they may be taken in the rest of the State from November 10 to February 10 in any manner. Skunks may not be hunted, pursued, or killed by aid of dogs.

North Dakota.—The fee for a resident trapping license is increased from $1 to $2. Mink, muskrat, skunk, and raccoon may be raised in domestication under a $5 breeder's license, and wild fur animals may be taken at any time for breeding purposes under permit and $500 bond. Otters are protected indefinitely.

Ohio.—Licenses to trap fur animals required (fees, resident, $1; nonresident, $15). It is unlawful to destroy the house, den, or burrow of any fur animal. The former season of November 15 to February 1 is changed to December 1 to March 1 on muskrats, and to November 1 to February 1 on raccoon, mink, skunk, and opossum. The period from October 2 to January 1 is fixed as the open season on foxes instead of October 2 to January 9.

Pennsylvania.—The bounty on wildcats is increased from $6 to $8, and on weasels from $1 to $2.

Rhode Island.—The period from November 1 to February 1, instead of November 1 to April 15, is fixed as the open season on raccoon.

South Carolina.—Hunting licenses are required to take fur animals. State open seasons from October 1 to March 15 on bear, mink, muskrat, opossum, otter, raccoon, and skunk, and from October 1 to February 15 on foxes are prescribed in lieu of local protection in a few counties.

South Dakota.—The age limit for persons not requiring trapping licenses is reduced from 18 to 14 years. The fee for a nonresident trapping license is increased from $10 to $25. It is made unlawful for one person to set or operate more than 75 traps at one time. Otter and beaver are protected indefinitely, and the open season on mink, skunk (formerly unprotected), and muskrat is shortened one month by being fixed from noon December 1 to noon March 1.

Utah.—Marten are protected indefinitely. Possession of skins of protected fur animals is prohibited, unless duly tagged by commissioner. Fifty per cent of the proceeds from the sale of hides of beaver taken under permit must be paid by commissioner to trappers as compensation for trapping the animals. Formerly all the proceeds of such sales were covered into the State game fund. Bounties are increased, on wolf, from $50 to $62.50; on bear and mountain lion or cougar, from $25 to $30; on coyote, from $2.50 to $4; and on lynx or bobcat, from $2.50 to $3.

Vermont.—A $10 bounty is prescribed for black bear taken in the State between May 1 and November 1.

Washington.—A breeder's license (fee, $10; renewal, $5) is required to raise fur animals in captivity.

West Virginia.—The open season on red fox, raccoon, mink, and muskrat, the only fur animals protected, is made November 1 to February 1 instead of November 1 to December 31.

Wisconsin.—The open season on beaver in Price, Rusk, and Sawyer Counties is changed from the month of December to the months of February and March. The season on raccoon in Marathon County is fixed as August 15 to January 1. The season on muskrats in

Calumet, Manitowoc, and Sheboygan Counties is fixed as March 1 to April 15.

Wyoming.—A license (fee, $1) is required for each dog used in hunting predatory animals on national forests during the close season for big game, and the fee for a permit to hunt predatory animals is reduced from $5 to $3. Continuous protection on beaver is extended to 1925.

Manitoba.—The fee for resident trapping licenses is increased from 50 cents to $2, and for resident fur-trading licenses from $5 to $10. Fur traders were allowed until September 30 to file a report on their dealings.

New Brunswick.—Continuous protection on beaver and sable is extended to July 1, 1920.

Saskatchewan.—The period from December 1 to April 30 is fixed as the open season on beaver throughout the Province (formerly beaver were protected throughout the year south of Churchill River and the season north of that river was from November 1 to April 30). The lieutenant governor in council may prohibit the killing of beaver in any municipality. The bounty on timber wolves is increased from $5 to 10.

Yukon.—It is made unlawful to export raw furs except under permit issued by the commissioner and upon payment of an export tax.

FEDERAL LAWS.

Two Federal laws have a bearing on the fur industry of the United States—the Lacey Act, governing interstate commerce in game, and the tariff act of October 3, 1913.

That part of the Lacey Act codified as section 242 of the Criminal Code (35 Stat., 1137) makes it unlawful to ship or transport "from any State, Territory, or District of the United States, to any other State, Territory, or District thereof" the bodies or parts of bodies of any wild animal or bird killed or shipped in violation of law of the State, Territory, or District in which the same were killed or from which they were shipped. This makes it unlawful to ship out of any State skins or pelts illegally taken or shipped. Section 243 of the Criminal Code, requires packages containing furs, when shipped in interstate commerce, to be plainly marked, so that the name and address of the shipper and the nature of the contents may be readily ascertained by inspection of the outside of the package.

The tariff act of 1913 places a duty of 10 per cent ad valorem on live animals shipped into the United States. Paragraph 397 of this act places on the free list animals imported for breeding purposes by a citizen of the United States: "*Provided*, That no such animal shall be admitted free unless pure-bred of a recognized breed and duly registered in a book of record recognized by the Secretary of Agriculture for that breed." This act has made it impossible thus far to admit free of duty any foxes or other Canadian fur animals for propagation. Raw furs not advanced in manufacture are admitted free of duty.

LAWS OF STATES AND PROVINCES.

The following is a summary by States and Provinces of trapping regulations now in force, open seasons for taking fur animals, provisions relating to their propagation and possession, and to bounties offered for the destruction of predatory species, or those considered harmful.

The laws relating to deer and other big game, rabbits, and squirrels are not considered here, as they appear in the annual game-law bulletin.[1]

Laws relating to bears are included, mainly because of their connection with bounties. The bounty laws included relate to all animals on which bounty is paid.

Under the heading "Open seasons" the dates given are, unless otherwise stated, *the first and last days of the open season.*

Under the heading "Trapping" the expression "no legislation" indicates that no specific trapping provisions exist, the general trespass laws of the State not having been considered.

ALABAMA.

Open seasons.—Beaver, otter, bear, fox, raccoon, opossum, mink, and muskrat may be trapped from November 1 to March 1; opossums may be hunted with dog or gun from October 15 to March 1.

Possession of opossum and the young of protected fur animals during close season prohibited. Owner may protect premises in any manner at any time from depredations of fur animals.

Trapping.—Trapping license (good during trapping season) required (fee, $10); issued by probate judge. Owners, tenants, and members of families may trap on own land during open season without license. Unlawful to trap on lands of another without written permission from owner or agent. Poisons, drugs, or chemicals may not be used in taking game or fur animals.

Propagation.—No legislation.

Bounties.—None paid.

ALASKA.

Open seasons.—Land otter and mink, November 16 to March 31; fox and weasel, November 16 to March 14; muskrat, December 1 to May 31; lynx (wildcat), November 16 to February 29. No close season for black bear, wolf, wolverine, ground squirrel, or rabbit.[2] Close season on marten until November

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[1] Farmers' Bulletin 1077, "Game Laws for 1919."

[2] *South of latitude 62°.*—Open season for brown bear, October to July 1; walrus and sea lions, no open season. *North of latitude 62°.*—Open season for walrus and sea lions, August 1 to December 10; limit, 1 each a season; no close season for brown bear or sea lion.

15, 1921; on sea otter until November 1, 1920; on beaver until November 1, 1923. No open season in Aleutian Islands Reservation, where trapping may be done only by special permit.[1]

Trapping.—The Secretary of Commerce makes all regulations for taking fur animals in Alaska. Under regulations published March 16, 1918, it is unlawful to use a "klips" trap, a steel bear trap, or any trap having a spread exceeding 8 inches; to kill fur-bearing animals with strychnin or other poison; to trap protected fur animals at any time when the skin or pelt is not prime; or to have in possession or sell or export unprime skins of animals protected by close seasons (such skins subject to confiscation). Shipments of furs must be reported to the Bureau of Fisheries, Department of Commerce, on blanks provided for that purpose.

Propagation.—Owners of establishments for breeding fur animals are subject to the same restrictions as to season for killing and condition of pelts as are trappers of wild fur-bearing animals. Fur farmers are required to furnish reports to the Bureau of Fisheries and to allow agents of that bureau free access to establishments where animals are kept in captivity.

Within the Aleutian Islands Reservation the Department of Agriculture grants permits to propagate fur animals and to trap them for breeding purposes.

An act of the territorial legislature protects premises of fox breeders or breeders of other fur animals from trespass.

Bounties.—Wolf, $15; eagles, 50 cents.

ARIZONA.

Open seasons.—Beaver protected until December 31, 1922. No close season on other fur and predatory animals.

Trapping.—State trapping license (fee, $2.50) required of persons over 18 years of age to hunt or trap fur and predatory animals. Issued by warden, designated deputies, and clerks of boards of supervisors. License not required for trapping on own land. Predatory and fur animals defined as mountain lion, bear, wolf, coyote, civet and ring-tailed cats, leopard, fox, beaver, otter, badger, fisher, skunk, raccoon, opossum, mink, marten, weasel, muskrat, mole, and wood rat. Unlawful to disturb or remove the traps of a licensed trapper who is trapping on the public domain or on lands for which he has permission to trap. Unlawful to use fish or the flesh of any game bird or animal for trap bait. Owner may protect his premises from the depredations of predatory and fur animals at any time. Mountain lion, wolf, fox, coyote, lynx, wildcat, skunk, or other obnoxious animal may be taken on State game preserves only under regulations of the State game warden.

Propagation.—Under permit from State game warden, fur-bearing and predatory animals may be kept for propagation, exhibition, or sale.

Bounties.—County boards are required to pay for wolf or mountain lion, $10 each; and may pay for coyote, $2; lynx or wild cat, $1; raccoon, 25 cents; jack rabbit, gopher, or prairie dog, 5 cents.

ARKANSAS.

Open seasons.—All fur animals, except beaver, otter, and bear, October 1 to February 29; bear, November 10 to January 15 (limit, one a season);

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[1] The fur-seal fisheries, the Aleutian Islands Reservation, and the Afognak Reservation are subject to special legislative and administrative control. For specific information regarding them, application should be made to the Commissioner of Fisheries, Washington, D. C.

beaver and otter, no open season before January 1, 1922. Raw skins of fur animals may not be possessed or sold, except between October 1 and March 15. Fur animals found destroying crops or poultry may be killed at any time.

Trapping.—A person using 12 or more traps to take fur animals is required to secure an annual trapper's license (fee, $20). Unlawful to trap bears, to hunt them at night with torch or searchlight, or to sell or exchange them; export is prohibited except by non-resident licensee under affidavit that the bear was legally taken and is not for sale. Hunting license required to kill bears. Fee, resident, $1.10; non-resident, $15; dog, used in hunting bears, $1.50.

Propagation.—The game and fish commission is authorized to issue permits to breeders of game and fur animals under such regulations as it may prescribe.

Bounties.—County courts may offer bounty on wolf, wild cat, or panther, and fix the amount of such bounty.

CALIFORNIA.

Open seasons.—No open season for beaver or sea otter. Open season for black or brown bear, ring-tail cat, coon, pine marten, fisher, wolverine, mink, skunk, river otter, and fox, October 15 to February 29. Seals and sea lions are protected at all times in game district 19.

Trapping.—Trapping license; citizen of United States, fee, $1; alien, $2. License issued free to trappers 18 years old or under. Licensed trappers, except those 18 or under, are required to report catch before July 1. Fur animals may be killed at any time when destroying property. Unlawful to use poisons in taking fur animals or to dig or smoke out skunks from dens. Use of gun larger than No. 10 gauge prohibited.

Propagation.—No legislation.

Bounties.—Mountain lion, female $30; male, $20; paid by State game commission. Boards of supervisors of counties may at their discretion fix the rate and pay bounty on coyote, wild cat, fox, lynx, bear, or mountain lion. Many counties now pay a bounty on some of these animals, especially on coyotes.[1]

COLORADO.

Open seasons.—No close season for fur animals, except beaver.

Trapping.—Hunting license required for trapping; fee, resident, $2; non-resident, $25. Beavers may not be trapped for fur at any time, but the owner of property damaged by the animals may apply to the State game and fish commissioner for a permit to kill them under such regulations as he may provide as to the disposition of the skins.

Propagation.—No restrictions, except as to beaver and game animals.

Bounties.—None paid by State since 1895. On petition of 50 freeholders, county commissioners may levy a tax to pay a bounty on coyote, wolf, and mountain lion.

CONNECTICUT.

Open seasons.—Otter, November 1 to March 31; raccoon, October 16 to January 31, but landowner may kill the animals at any time to protect property; skunk, November 1 to January 31; may be taken at any time to protect property. No close season on other fur animals.

Trapping.—Unlawful to trap with scented baits; to trap on lands of another without permission; and to take animals with a snare or similar device. Traps must be visited at least once in 48 hours and must not be set in path, wood road, or specially prepared furrow. Hunting license is required for trapping (except of a resident on own land); fee, resident, $1; nonresident, $10; alien, $15; with an additional 25 cents recording fee for each license. Persons under 16 years of age, while denied a hunting license, may obtain one for taking fur animals only.

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[1] For information in regard to bounties in any county, application should be made to the county clerk.

Propagation.—No restrictions on possession or sale of fur animals kept in captivity.

Bounties.—Towns are permitted to pay bounty on wild cat or fox (not over $5); on weasel, woodchuck, wild Belgian hare, or wild German rabbit (not over $1).

DELAWARE.

Open seasons.—Skunk, mink, and otter, December 1 to March 25; fox, October 1 to April 30; raccoon and opossum, October 1 to January 1; muskrat, December 1 to March 10.

Trapping.—Nonresident trappers are required to hold hunting license (fee $10.50). Unlawful to use pitfall, deadfall, scaffold, cage, snare, trap, net, pen, baited hook, or baited field or any other similar device, or any drug, poison, chemicals, or explosives for taking birds or animals protected by the laws of this State, except muskrats, skunks, minks, and otters, and except as otherwise expressly provided. Traps or other devices unlawfully set are subject to confiscation. Muskrats may not be taken during the time of any flood or freshet when such flood or freshet may cause them to leave their usual places of shelter and protection. Muskrats may not be shot at night or hunted with a dog. Unlawful to destroy the nest, den, or lair of any animal protected by law. Unlawful to hunt, kill, take, or destroy any protected animal, except muskrat, skunk, mink, and otter, while the ground is covered with snow. Unlawful to shoot at or destroy any fox while such fox is being chased by dog or dogs. Unlawful to sell or export any fox or fox hides. Owners of property may at any time destroy fur-bearing animals to protect such property.

Propagation.—No restrictions, provided a permit is obtained from the chief game and fish warden (fee, $1). A restricted number of wild fur or game animals for propagating purposes may be taken under permit.

Bounties.—None paid.

DISTRICT OF COLUMBIA.

No legislation relating to fur animals.

FLORIDA.

Open seasons.—Beaver and otter, November 1 to January 31. No close season for other fur animals.

Trapping.—No legislation.

Propagation.—No legislation.

Bounties.—None paid.

GEORGIA.

Open seasons.—Opossum, October 1 to February 29; fox, Habersham County, September 1 to May 14. Fur animals not otherwise protected.

Trapping.—Permission of owner required to trap on lands of another. Hunting license required to trap outside one's own militia district; fees for State license, nonresident, $15; resident, $3; county license, $1.

Propagation.—No restrictions on propagation of unprotected fur animals.

Bounties.—None paid.

HAWAII.

Hawaii has no wild animals valuable for fur. There are no restrictions on the propagation of fur animals, except that mongooses and rabbits may not be kept or bred. Pet rabbits may be raised, if kept in confinement.

IDAHO.

Open seasons.—Beaver, otter, marten, mink, muskrat, raccoon, fox, and fisher, October 1 to March 31; bear unprotected. Predatory animals—mountain lion, wolf, coyote, lynx, bobcat, jack rabbit, skunk, and weasel, unprotected.

In Black Lake Game Preserve, beaver, otter, marten, fisher, fox, mink, and wolverine are protected at all times; mountain lion, bear, lynx, wolf, coyote, and wildcat may be destroyed by game warden or duly authorized persons.

In Payette Game Preserve, bear, lynx, wolverine, fox, otter, beaver, marten, mink, and fisher are protected at all times; mountain lion, timber wolf, coyote, and wildcat may be killed by game wardens or duly authorized persons.

In Selway and Big Lost River Game Preserves, beaver, otter, marten, fisher, fox, and mink are protected at all times; mountain lion, bear, lynx, wolf, coyote, wolverine, and wildcat may be killed by game wardens or duly authorized persons. In Big Lost River Preserve, badgers, weasels, skunks, and rabbits may be killed by anyone without permit.

In Big Creek Game Preserve, beaver, otter, marten, fisher, fox, and mink are protected at all times; mountain lion, lynx, timber wolf, coyote, and wildcat may be killed by game wardens or duly authorized persons.

Trapping.—License required to trap fur-bearing animals: Resident, $5; nonresident, $25; alien, $50. Issued by warden, deputy, or authorized agent. Licensed trapper must make verified report at end of season of number and kind of fur caught, where sold, and the price received therefor. Skins of fur or other animals legally taken, within or without State, may be possessed or sold at any time. Unlawful to destroy, disturb, or remove traps of licensed trapper. Unlawful to use flesh of any game bird or game animal for bait in trapping or taking fur-bearing animals. Muskrats may be destroyed in irrigated districts, but muskrat houses may not be disturbed except under permit of State warden to protect private or public ditch or water course. Person may protect own premises from depredation of fur-bearing animals, under permit from State warden.

Propagation.—Permit from State warden required. Permittee must make verified yearly report showing number of animals kept in captivity, number sold, and number on hand.

Bounties.—Coyote, lynx, or wildcat, $2.50 each; bear or wolf, $10; mountain lion, $25; paid from predatory wild animal funds administered through the State live stock sanitary board. Bounty of 2 cents each on pocket gopher, ground squirrel, and prairie dog; fund raised by taxation; administered like predatory wild animal fund.

ILLINOIS.

Open seasons.—Raccoon, mink, muskrat, skunk, opossum, fox, and otter. November 1 to March 15. Possession of green hides of fur-bearing animals prohibited except from November 1 to March 25.

Trapping.—License required to trap fur-bearing animals: Resident, $1; nonresident, $10.50. Issued by county, city, or village clerk. Expires March 15. Licenses not required of landowners and tenants and members of families to trap during open season on the lands on which they reside. License not issued to person under 16 years of age without written consent of parent or guardian.

Holder of a license, within 30 days after its expiration, must report all hides of fur-bearing animals taken, sold, shipped, or dealt in, together with names and addresses of persons to whom sold or shipped.

Unlawful to use spear or similar device for hunting or taking fur-bearing animals, or explosives, chemicals, or mechanical devices or smokers of any kind to drive them out of their burrows, dens, or houses. Houses and dens of fur-bearing animals protected except when they obstruct a public or private ditch or watercourse. Use of automobile or vehicle propelled by mechanical power, or the lights thereof, or ferret in hunting or taking fur-bearing animal prohibited. Unlawful to trap on lands of another without permission from owner, agent, or occupant.

Propagation.—Permit is required to conduct a fur farm on which protected animals are reared; fee, $2.

Bounties.—None paid by State. Counties may at their discretion pay bounty on ground hog and crow.

INDIANA.

Open seasons.—Beaver, raccoon, fox, otter, opossum, and skunk, November 20 to February 1; mink and muskrat, November 1 to March 31. Muskrat houses protected at all times except when obstructing ditches or watercourses.

Trapping.—Nonresident trapper requires license (fee, $15.50). Trapping on lands of another without written consent of owner, occupant, or lessee is unlawful. Traps set on such lands must be placed within burrow of animal or a hollow log and must be visited at least once in each 36 hours. Protected fur animals may be killed at any time on one's own premises to protect property.

Propagation.—All birds and animals raised in captivity are considered domestic stock, and the owner may possess, sell, ship, transport, or otherwise dispose of them without regard to laws regulating the killing and disposition of wild birds and animals.

Bounties.—Crow, 10 cents each; may be paid by counties. Boards of county commissioners are authorized at their discretion to pay bounty on wolf, fox, woodchuck, owl, or hawk.

IOWA.

Open seasons.—Beaver, mink, otter, and muskrat, November 15 to March 15; may be destroyed at any time to protect public or private property. Muskrat houses are protected at all times. Possession of beaver, mink, otter, or muskrat is lawful only during open season and first five days of close season.

Trapping.—Hunting license required for trapping; fee, resident, $1; nonresident, $10.50.

Propagation.—No restrictions except as to possession of protected species.

Bounties.—Adult wolf, $20; wolf cub, $4; wildcat, $1; paid by county. Boards of supervisors of counties may allow bounty on crow, ground hog, pocket gopher, or rattlesnake.

KANSAS.

Open seasons.—Muskrat, skunk, mink, raccoon, opossum, and civet cat, November 15 to March 15. No open season for beaver or otter until 1921.

Trapping.—The owner or legal occupant of land may destroy fur-bearing animals protected by law when such animals are destroying poultry or damaging other property. Unlawful to hunt or kill any wild animal upon the lands of another without his written permission.

Propagation.—No legislation.

Bounties.—Coyote, $1; wolf, $5; crow and pocket gopher, 5 cents each; paid by county.

KENTUCKY.

Open seasons.—Beaver, mink, raccoon, otter, opossum, and skunk, November 15 to December 31; but raccoon, opossum, skunk, and mink may also be taken and killed by dog or gun, October 1 to February 15.

Trapping.—Written consent of owner or lessee required to trap on lands of another. Traps must be set 18 inches or more within a hole, cave, or hollow log, and must be visited within each 36 hours. Traps set unlawfully may be seized or destroyed by anyone. Fur animals may be killed at any time on one's own premises to protect property.

Propagation.—No legislation.

LOUISIANA.

Open seasons.—Bear, November 1 to February 15 (may not be trapped); muskrat, mink, otter, raccoon, skunk, fox, and opossum, November 1 to February 15; beaver, no open season.

Trapping.—License for trapping is required; fee, resident, $2; nonresident, $15. Muskrats may be taken at any time within 5 miles of any levee, and may be killed by the owner of land upon which they are destroying property. Skins of animals killed in open season may be possessed in close season. Wild ducks may not be used for trap bait.

Propagation.—Fur animals for breeding purposes may not be captured during the close season. Permit from the department of conservation is required to import wild quadrupeds into the State or to export them from the State.

Bounties.—None paid.

MAINE.

Open seasons.—All fur animals (except beaver, muskrat, raccoon, bear, bobcat, Canada lynx (loup cervier), and weasel), October 15 to February 29; muskrat, October 15 to May 14; raccoon, August 15 to February 29. No open season on beaver except when declared by the commissioner of inland fisheries and game. No close season on bear, bobcat, Canada lynx (loup cervier), or weasel. Unlawful to transport or dispose of a beaver skin without official seal of commissioner attached.

Trapping.—Special beaver trapping license, good only in territory opened to beaver trapping by commissioner, fee $25. Trappers in unorganized townships of the State are required to take out an annual license except for bear and bobcat (fee $10), and on or before December 15 of each year must make such report as the commissioner of inland fisheries and game may require. Any person who sets a trap in an organized county or incorporated place must obtain written consent of the owner or occupant of land on which the trap is set, and must visit such trap at least once in every 24 hours and remove animals caught. All traps must be plainly marked with owner's name and address, either by having the same stamped on the trap or on a metal tag firmly attached to it. A bear trap must be inclosed in a "hut."

Dealers in skins of fur animals must each year take out a license (fee, State, $25; county, $2) to engage in this trade and must keep a record of transactions and forward same to the commissioner of inland fisheries and game on or before December 20. Putting out poison for wolves, foxes, dogs, or other animals is forbidden under penalty of fine or imprisonment.

Traps may not be set within 25 feet of a muskrat house. (Special laws in southern Oxford and certain territory in Washington County.) On complaint by landowners of damage done by beavers, the commissioner of inland fisheries and game has authority to declare an open season for beavers on lands where damage occurs. Any person may lawfully kill any wild animal, except beaver, found destroying his property. Unlawful to dig out a fox den at any time.

Propagation.—Permit required to raise fur animals (fee, $2). Protected species may be taken under special permits by licensed trappers for breeding purposes. No animals may be imported into the State without permit.

Bounties.—Bobcat and Canada lynx (loup cervier), $10 each; paid by State. Claim for bounty must be made within five days after killing or return from trip on which killing was done. Bounty on bears, $5 each; paid by State, claim to be made within 10 days after killing.

MARYLAND.

While the State has recently adopted a uniform open season for game, the counties still regulate the taking of fur animals. The State law of 1900 (ch. 371) protecting otter, raccoon, and muskrat between April 1 and January 1 was amended until it applied to only six counties in 1912 (ch. 843), some of which also have local laws that take precedence. Local laws providing protection to fur animals or regulating their capture are in force in the following counties:

Allegany County.—Raccoon and opossum, open season, September 1 to March 31; hunting license required to capture either. Muskrat, open season, January 1 to April 1. Bounty on wildcat, $2; fox, $1; hawk or hoot owl, 50 cents.

Anne Arundel County.—Raccoon, open season, October 1 to January 31; may not be taken between sunrise and sunset; unlawful to cut down tree to obtain a raccoon. Muskrat, open season, December 1 to March 1. Unlawful at any time to destroy muskrat dens or houses, unless the animals are destroying property.

Baltimore County.—Unlawful to set traps, except from November 10 to December 20. Unlawful to pursue or kill raccoon and opossums, except from October 1 to February 28 (inclusive); unlawful to hunt them on Sundays or when snow covers the ground. Permits to take certain predatory fur animals when destroying property may be obtained, but such permits may be revoked at any time by the chief game warden. Foxes may not be shot or shot at while pursued by dogs, and it is a misdemeanor to dig young foxes or vixen from dens.

Caroline County.—Muskrat, open season, December 15 to March 31; raccoon, September 15 to March 31; otter, December 15 to March 31. Unlawful for nonresidents to trap without license (fee, $4.50). Unlawful to dig into or destroy muskrat homes or dens, except when animals are destroying property. Unlawful to use reflector or artificial light in taking muskrats or otters. Unlawful to kill a fox except by hounds in a hunt or when the fox is destroying poultry.

Carroll County.—Unlawful to kill fox except by hounds in a hunt or when the fox is destroying poultry.

Cecil County.—Muskrat, open season, December 1 to February 28 (29); may be taken only by trapping.

Charles County.—Unlawful to shoot muskrats on Nanjemoy Creek and tributaries by aid of light.

Dorchester County.—Open season, raccoon, November 10 to March 14; otter, January 1 to March 31 (State law); muskrat, January 1 to March 15 (local law). Unlawful to shoot muskrats or to use artificial light in taking them. Bounty on crow, 5 cents.

Frederick County.—All fur animals, open season, November 15 to February 28 (29), but night hunting with dogs for raccoon or opossum is lawful at any time. Bounty on wildcat, $2; mink or fox, $1; weasel, owl, or hawk, 50 cents.

Garrett County.—Bounty on panther or wolf, $20; wildcat, $3; fox, $1; weasel, 50 cents.

Harford County.—Except for muskrats, trapping is forbidden between December 25 and November 15 of the following year. Open season for raccoon, October 2 to November 30. License required to take muskrats or skunks; fee, resident, $1.15; nonresident, $5.15. Unlawful to trap on private property without permission of owner. Bounty of 50 cents each on chicken hawk, pigeon hawk, booby owl, or weasel.

Kent County.—Otter, raccoon, and muskrat, open season, January 1 to March 31 (State law). Unlawful to shoot muskrat or otter by light at night.

Montgomery County.—Raccoon and opossum, open season, October 15 to January 14; muskrat, November 15 to February 28 (29). Nonresident requires license to hunt raccoon or opossum (fee, $15.50). Setting a snare or trap in or about a fox den is unlawful. Bounty on hawks, 40 cents.

Prince Georges County.—Unlawful to hunt, shoot, or trap muskrats in Aquasco district between March 15 and January 1, or to spear them at any time. Raccoon, open season, October 1 to January 31; may not be taken between sunrise and sunset; unlawful to cut down tree to capture raccoon.

Queen Annes County.—Otter, raccoon, and muskrat, open season, January 1 to March 31 (State law).

Somerset County.—Otter and raccoon, open season, January 1 to March 31 (State law); muskrat, January 1 to March 15 (local law). Unlawful at any time to shoot muskrats.

Talbot County.—Otter and muskrat, open season, December 16 to March 15. Dealers may have skins of either in possession up to March 31. Unlawful to take otter or muskrat at night, except in traps.

Washington County.—Muskrat, mink, skunk, opossum, and otter, open season, December 1 to March 31. Unlawful to shoot foxes while they are being chased by dogs.

Wicomico County.—Otter, mink, and muskrat, open season, January 1 to April 1. Muskrats may be taken only by traps and muskrat houses are protected at all times.

Worcester County.—Muskrat, otter, and mink, open season, January 1 to April 1. Unlawful to trap on lands or marshes of another without permission. Unlawful to chase fox with dogs, March 10 to August 31, or to shoot any fox while it is pursued by dogs.

Bounties.—A State bounty of 50 cents each on bird hawk or chicken hawk killed in the State, paid from the State game protective fund.

MASSACHUSETTS.

Open seasons.—Raccoon, October 1 to December 31. No close season for other fur animals.

Trapping.—Poison may not be used to kill animals, except rats, woodchucks, or other pests on one's own premises. The use of steel traps with spread of over 6 inches and "choke" traps with greater opening than 6 inches is unlawful, as is also the use of snares or, except with consent of landowner, of scented baits. Traps may not be set on inclosed lands of another without written consent. Traps must be visited at least once in 24 hours. Animals "may be taken from traps on the Lord's day," but traps may not be set or reset. Introduction of foxes or raccoons in Dukes County is prohibited.

Propagation.—No legislation.

Bounties.—Seals, $2; wildcat or lynx, $5; paid by town, but refunded by county.

MICHIGAN.

Open seasons.—Beaver (under special license), November 1 to April 15; otter, mink, fisher, and marten, November 16 to February 14; raccoon, October 15 to December 31; muskrat, north of Range 20 north, October 16 to April 14; south of Range 21 north, December 16 to March 31. No close season for skunk, bear, wolf, coyote, fox, lynx, and wildcat.

Badger, beaver, and muskrat, in and within 2 miles of any city public park containing over 200 acres, of which 150 acres or more is woodland, no open season.

Trapping.—License required for trapping, or hunting bear and other unprotected animals; fee, resident, $1; nonresident, $10. A special license (fee, $10) is required for trapping beavers. Such license permits the taking of 15 beavers, not more than 4 from a single colony. Unlawful to destroy beaver houses or dams or to have carcass or skin in possession without license seal attached. Unlawful to molest dens of fur animals or to use spears, explosives, chemicals, mechanical devices, or smokers to drive animals from their holes or homes; unlawful to destroy beaver, muskrat, or skunk den or home, to shoot muskrats, or to set a trap within 6 feet of a muskrat house or hole, or to possess carcass or skin of fur animal killed in close season. Fur animals, except beavers, may be destroyed on one's own premises to protect property. Unlawful to trap on State game refuges.

Propagation.—Annual license (fee, $5) required to engage in raising fur animals. Live animals and skins of animals raised in captivity must be tagged (fee, 5 cents for each tag).

Bounties.—Wolf, $35; wolf cub under 6 months, $15; coyote, same as wolf; wildcat or lynx, $5; fox, $1; weasel, woodchuck, hawk, or owl, 50 cents; paid by county, half refunded by State. Boards of supervisors may pay additional bounties.

MINNESOTA.

Open seasons.—No open season for beaver or otter; raccoon, October 15 to March 1; mink, fisher, marten, and muskrat, December 1 to April 1. Black bear, skunk, weasel, wildcat, lynx, and fox, unprotected. The commissioner, in his judgment, may issue licenses (fee, $1; bond, $500) to trap a limited number of beaver in any locality; skins of beaver taken under proper license, when tagged with a $3 tag, may be bought, sold, or transported at any time.

Trapping.—Trapping license issued to residents only, fee $1. Unlawful to molest or destroy muskrat, mink, or beaver house, den, dam, or abiding place at any time or to hunt these animals with dogs. Mink, fisher, and marten may be taken in any manner, and muskrat may be taken by trapping only. Unlawful to take red fox cubs for shipment out of the State. If any of these animals are damaging property the owner may obtain a permit to kill them and destroy their houses or dams. Skins or pelts legally taken may be possessed, bought, or sold at any time. Package or receptacle containing wild quadruped or part thereof when transported by a common carrier must have attached a proper coupon tag bearing signature of licensee shipping same, and show his address and license number, together with number and kinds of wild animals or parts thereof contained in the shipment.

Propagation.—Wild animals raised in captivity under a $1 permit from the State game and fish commissioner may be sold for breeding or stocking purposes at any time, and under regulations of the commissioner may be killed and any part thereof sold or transported. Under regulations of the commissioner, wild animals may be captured during the open season for breeding purposes.

Bounties.—Wolf, $7.50; cub wolf, $3 (paid by State). County or town boards may offer bounty on wolf, gopher, ground squirrel, groundhog, rattlesnake, crow, or blackbird.

MISSISSIPPI.

Open seasons.—Bear, November 1 to end of February.

Trapping.—No legislation.[1]

Propagation.—No legislation.

Bounties.—None paid.

MISSOURI.

Open seasons.—All fur animals, November 1 to January 31.

Trapping.—Wild fur-bearing animals may be destroyed at any time and in any way to protect premises from their depredations, and pelts of animals so killed may be removed and marketed in the usual way. Unlawful to sell or offer for sale pelts of fur animals taken out of season. Written permission required to trap on lands of another. Use of poison prohibited in taking any protected animal.

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[1] The act for protection of game and fur animals (1916, ch. 99) was defeated by referendum vote.

Propagation.—Permits to capture for propagating purposes may be obtained from the State game and fish commissioner, fee $5. Breeder's permit, fee $5.

Bounties.—Adult wolf or coyote, $6; young wolf or young coyote, $3; paid by county and one-half refunded by State.

MONTANA.

Open seasons.—Marten, September 15 to May 1. Beaver may be taken only under a license; provided, taxpayers, owners of real estate, or their authorized agents, may kill beaver on their own premises for the protection of their ditches, dams, etc., but such killing must be reported in writing to the State game warden within 30 days. The skins of animals so taken may be shipped or sold under permit from the warden by the persons killing the animals, but permittees are required to report name of purchaser and number of skins sold.

Trapping.—License (fee, $1.50) required for trapping, except for wolves, coyotes, and mountain lions. Special license required for trapping beavers, and permit required to sell beaver skins. Special license (fee, $5) required for trapping on State game preserves. Marten trapping license, fee $1.

Propagation.—No legislation.

Bounties.—Grown wolf, $15; wolf pup, coyote, or coyote pup, $2.50; mountain lion, $10; paid from State bounty fund raised by tax on live stock.

NEBRASKA.

Open seasons.—Muskrat, opossum, and otter, November 20 to March 20; skunk, raccoon, September 20 to March 20; mink, December 1 to January 31. Unlawful to destroy muskrat houses on premises of another. Beaver, no open season, but if the animals are damaging property a permit to destroy them may be obtained from the chief deputy, game and fish commission. No close season for other fur animals; any except beavers may be taken at any time on one's own premises.

Trapping.—Trapping license, resident, $2; nonresident or alien, $10. Unlawful to trap on premises of another without consent of owner.

Propagation.—No legislation.

Bounties.—Such counties as have at any general election voted to pay bounties, pay for wolf, $3; wildcat or coyote, $1; mountain lion, $3.

NEVADA.

Open seasons.—No close season except on beavers, which may not be taken until January 1, 1920.

Trapping.—No legislation.

Propagation.—License (fee, $10, paid anually to county) required from those who wish to propagate game or fur animals (except beaver). Animals on breeder's own lands may be taken at any time for propagation, and those held in captivity by holder of license may be sold at any time. No bounty may be collected on noxious species raised in captivity.

Bounties.—Mountain lion, $5; lynx or wildcat, $2; paid by county. Counties pay bounty of 1½ cents each for pocket gophers when at least 100 heads are presented at one time.

The State board of live-stock commissioners is authorized to pay bounty from funds derived from tax on horses, cattle, and hogs. The rewards are, for coyote, coyote pup, wildcat, or lynx, 75 cents each; mountain lion, $5.[1]

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[1] No bounties have been paid under the provisions of this law.

The State board of sheep commissioners is authorized to pay bounty from funds derived from tax on sheep, the payments being the same as those made by the board of live-stock commissioners.[1]

NEW HAMPSHIRE.

Open seasons.—All fur-bearing animals, except beaver, November 1 to February 29, except muskrats may be taken from the waters of the Connecticut River from November 1 to March 31. No open season for beaver. Raccoons and foxes may be taken by use of dog and gun during October.

Trapping.—Fur-bearing animals defined as beaver, otter, marten, sable, mink, raccoon, fisher, fox, skunk, and muskrat. The right of anyone to kill predatory fur animals at any time when destroying domestic animals or fowls is granted. Skins legally taken may be bought or sold at any time. No person may destroy a muskrat house or set a trap therein, thereon, or at the entrance thereof. No person may trap upon lands of which he is not owner or lessee. All traps must be legibly marked or stamped with trapper's name, and must be visited at least once in 24 hours. It is an offense punishable by a fine to take traps of another or remove fur animals from them. Unlawful to use spring gun, snare, or poison in taking fur animals. Bear traps must be safeguarded in a substantial manner. License for trapping, except on private lands, is required; fee, resident, $1; nonresident, $15. Trappers are liable for any damage to domestic animals by traps.

Unlawful to tear down or destroy any fence or wall, leave open any gate or bars, or trample or destroy any crop, on land of another, while trapping or pursuing any wild animals.

Propagation.—Permit (fee, $2) required to propagate fur animals, game, or fish.

Bounties.—Bear, $5; hedgehog, 20 cents; wildcat, $5; paid by State.

NEW JERSEY.

Open seasons.—Skunk, mink, muskrat, and otter, November 15 to April 1; raccoon, October 1 to December 15. Beaver, unlawful to trap, take, kill, or have in possession at any time. The board of fish and game commissioners may grant permits to hunt foxes with hound and firearms from the last day of the open season for quail (December 15) to May 31.

Trapping.—Skunks, minks, muskrats, and otters may not be taken in close season, except that muskrats may be destroyed by owner of canal or dam which they are destroying. Muskrats, skunk, mink, otter, may be taken by trap only, except in Salem County, above Mill Creek, where they may be taken in open season by firearms and light. It is unlawful to disturb the lodge or nesting chamber of muskrats, to molest traps set by another, or to appropriate or take animals caught in such traps.

Propagation.—No restrictions except those imposed by close seasons, during which wild animals may not be taken for breeding purposes. Breeder's license, fee $5.

Bounties.—Fox, $3; paid by counties.

NEW MEXICO.

Open seasons.—No close season for fur animals, except beavers, which are protected at all times; provided, when beavers are destroying property they may be killed under permit from state game and fish warden.

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[1] No bounties have been paid under the provisions of this law.

Trapping.—No legislation.

Propagation.—Permit from State game warden required.

Bounties.—Coyote, wildcat, or lynx, $2; wolf, $15; panther or mountain lion, $10; paid from county wild-animal fund, raised by tax on property.

NEW YORK.

Open seasons.—Mink and sable November 10 to March 15; raccoon may be taken otherwise than by trapping in the Catskill Park, October 1 to March 15; raccoon, elsewhere in State, November 10 to February 10; skunk, November 10 to February 10; muskrat, November 10 to April 20. No open season for beaver.

Trapping.—License required for hunting or trapping; fee, resident, $1.10; nonresident, $10. Muskrat houses may not be molested, injured, or disturbed, nor the animals shot at any time. Skunks may not be taken by the aid of dogs or by digging out or driving them from dens or holes by smoking or the use of chemicals; if injuring property, they may be taken at any time and in any manner, but the skins of animals so taken shall not be possessed, sold, bought, or trafficked in. Unlawful to set traps during close season.

Propagation.—All protected fur animals may be kept alive in captivity for propagation and sale, provided a license be obtained from the conservation commission (fee, $5). No fur-bearing animals may be kept which are taken wild during close season for such animals (unless taken under license); nor may they be disposed of during close season. The conservation commission is authorized to issue license to capture animals for propagation; fee for permit, $1.

Bounties.—Panther, $20, paid by State; none paid since May, 1884.

NORTH CAROLINA.

[More than half of the 100 counties in the State have local laws relating to fur animals, and information regarding open seasons, license requirements, and trapping and hunting restrictions may be obtained from the secretary, Audubon Society of North Carolina, Raleigh.]

NORTH DAKOTA.

Open seasons.—Mink and muskrat, November 16 to April 14; otter, no open season; beaver, January 10 to March 10. Only licensed trapper may take beaver, but not upon posted lands. Possession of green hides of mink or muskrat illegal after April 19.

Trapping.—Licenses are required of persons over 16 years of age to trap except on their own lands; fee, resident, $2; nonresident (mink and muskrat only), $25. The protected fur animals are mink, muskrat, otter, and beaver; but minks and muskrats may be killed at any time by owner of property destroyed by them. Muskrat houses are protected at all times.

Propagation.—The State game and fish board issues permits (fee, $5) to breed and domesticate mink, muskrat, skunk, and raccoon, and also permits to sell or ship them when raised in captivity. Under permit from board and $500 bond, wild fur animals may be taken at any time for breeding purposes. Annual reports are required of licensed breeders.

Bounties.—Wolf or coyote (killed within State), $2.50 each; paid from fund raised by direct taxation on all property.

OHIO.

Open seasons.—Raccoon, mink, skunk, and opossum, November 1 to February 1; muskrat, December 1 to March 1; fox, October 2 to January 1. Protected animals may be destroyed by owner of premises (except on Sunday) when damaging property.

Trapping.—Hunting and trapping license required, fees, resident, $1, nonresident, $15. License not required of owners, managers, tenants, or their children to trap during open season on own land. Written permission from owner or authorized agent required to trap on lands of another. The close season for certain fur animals does not prohibit owners or tenants of land from destroying them to protect property. Digging out dens or smoking, or drowning the animals therefrom is unlawful, as is also the destruction of the house, den, or burrow of any fur animal.

Propagation.—No restrictions, except those which prevent capture of wild stock in close season.

Bounties.—Townships pay a bounty of $1 each on certain hawks and great-horned owl; 20 cents per dozen on English sparrows; and, under certain conditions, 10 cents each on ground hogs.

OKLAHOMA.

Open seasons.—No open season for otter or beaver. Other fur animals, November 1 to March 1. No open season for bear in Comanche, Caddo, Kiowa, Major, and Blaine Counties.

Trapping.—Unlawful to sell pelts of fur animals taken between March 1 and November 1.

Propagation.—The State game warden issues permits to propagate fur-bearing animals, game, and fish; cost, $2, together with fees for tagging. Licensed breeders may sell and transport animals raised in preserves under rules prescribed by the warden.

Bounties.—County commissioners are authorized to offer bounty on gray wolf ($3) and coyote ($1). Bounties on hawks, crows, etc., paid by counties (not to exceed $200 a year in any county) are refunded to county from State game fund.

OREGON.

Open seasons.—Mink, otter, fisher, marten, and muskrat, November 1 to February 28, inclusive. No open season for beaver. No open season for fur animals on State game preserve.

Trapping.—License (fee, $1) is required of all persons over 16 years of age to trap on lands not their own. No flesh of game animal or bird may be used to bait traps. Unlawful to remove or disturb traps of a licensed trapper on public domain or on lands where he has permission to trap. Licensed trappers are required to make annual reports of number of animals caught and receipts for fur sold. If beavers or other fur animals damage property, permits to kill them may be obtained from the State board of fish and game commissioners. Skins of such animals are the property of the State, to be sold and the proceeds used in paying for damage to property. Unlawful to destroy muskrat house, except where it obstructs ditch or watercourse.

Propagation.—Permits (fee, $2) to keep fur-bearing animals may be obtained from the State board. No wild fur animals may be taken for propagating purposes in close season nor may those held in captivity under permit be sold in that season. Yearly reports to the State board are required.

Bounties.—Coyote or coyote pup, $3; adult female, coyote, $4; gray, black, or timber wolf, or wolf pup, $2.50; bobcat, wildcat, or lynx, $2; mountain lion, panther, or cougar, $10; seal or seal pup, $2.50; paid by county and half refunded by the State. The State board is empowered to pay additional bounties, at its discretion, on any predatory animal in order to protect game; under this act the State board now pays for wolf, $20; for cougar, $15. Several counties are authorized by law to levy a special tax and pay bounties on moles, rabbits, or gophers.

PENNSYLVANIA.

Open seasons.—Bear, October 15 to December 15; raccoon, September 1 to December 31. No open season for beaver. Foxes may not be trapped, shot, snared, or poisoned in Delaware County.

Trapping.—Nonresident trapper requires license (fee, $10). Unlawful to trap bears, and only one may be killed in a season or 3 to a camp or body of men. No steel traps larger than No. 3 size may be used for trapping wildcats or other fur animals. Resident requires no license for trapping, but hunting licenses required for killing raccoons or bears, which are regarded as "game" animals (fee, $1).

Propagation.—No restrictions on raising fur animals, except that possession and breeding of ferrets is unlawful except under license from the State board of game commissioners; fee for license to breed and sell ferrets, $25; to possess a ferret without breeding, $1.

Bounties.—Wildcat, $8; fox, $2; mink, $1; weasel, $2; paid from special fund created by setting aside one-half the receipts by the board of game commissioners from gun licenses, fines, etc.

PORTO RICO.

Porto Rico has no wild fur animals.

RHODE ISLAND.

Open seasons.—Skunk, muskrat, and mink, November 1 to April 15; raccoon, November 1 to February 1. Landowners may kill protected animals on their own lands at any time.

Trapping.—Hunting license is required for trapping, except on one's own lands; fee, resident, $1; nonresident, $10; alien, $15; together with an additional fee of 15 cents for issuing license. Unlawful to trap on posted lands or on lands of another without written permission. Unlawful to set wire snares, or to use steel traps with teeth or with spread over 6 inches, or choke traps with greater opening than 6 inches. Traps must be concealed so as not to endanger domestic animals and must be visited at least once in 24 hours.

Propagation.—No legislation.

Bounties.—Fox, $3; crow and certain hawks and owls, 25 cents; paid by State.

SOUTH CAROLINA.

Open seasons.—Bear, mink, muskrat, opossum, otter, raccoon, and skunk, October 1 to March 15; fox, September 1 to February 15. Foxes and wildcats may be killed without license at any time by officers of the law and landowners upon their own holdings.

Trapping.—Hunting license required, fees, resident, county license, $1.10; State, $3.10; nonresident, $15.25. No license required of land owner, member of his family or, under his written permission, an employee to take fur animals on own land during open season. Unlawful to hunt on lands of another without consent of owner or manager.

Propagation.—No legislation.

Bounties.—None paid.

SOUTH DAKOTA.

Open seasons.—Mink, muskrat, skunk, from noon December 1 to noon March 1. Otter and beaver, no open season.

Trapping.—Trapping license required of residents over 14 years of age, fee $5. No license required of landowners trapping on own lands during open season. Nonresidents trapping license, fee $25.

No person shall set or operate more than 75 traps at any one time. Unlawful to shoot muskrats, or to destroy or molest muskrat houses, except they may be opened without injury thereto for the purpose of placing traps therein during open season. Unlawful to buy, sell, ship, or have in possession raw skins of protected fur animals during close season.

Skunk doing damage around buildings may be killed at any time, and, under permit from State game warden, muskrats or beaver damaging irrigation ditches, embankments, or public highways may be taken at any time.

Propagation.—No restrictions, except that protected animals may not be taken for breeding purposes in close season.

Bounties.—Counties shall pay $4 for coyote and $8 for wolf, killed within the county.

TENNESSEE.

Open seasons.—For trapping fur bearers off one's own land, from noon October 15 to noon January 15.

Trapping.—Owner of land may hunt or trap on such land at any time; others may do so only with written consent of owner. Steel traps must be placed at least 12 inches within the entrance to a hole, cave, den, or hollow log. Traps and deadfalls must be inspected within each 36 hours, and captured animals removed; does not apply to trapping wildcats in Lauderdale County.

Propagation.—No legislation.

Bounties.—Wolf or panther, $2 certificate issued by county court, the amount to be applied on payment of taxes.

Local laws of counties:

Blount County.—Unlawful to shoot fox, to trap or injure young foxes, or to destroy their dens.

Carter and Johnson Counties.—Unlawful to trap, shoot, or kill fox or to destroy fox den, except near farm buildings when they destroy fowls or live stock.

Claiborne, Grainger, Davidson, Roane, and Shelby Counties.—Unlawful to set a trap more than 200 yards from trapper's residence.

Davidson, Robertson, and Shelby Counties.—Open season for beaver, muskrat, fox, mink, raccoon, skunk, and opossum, September 1 to January 31. Sale of these animals or their skins restricted to from November 1 to January 31.

Dyer County.—Open season for raccoon, mink, and otter, October 1 to February 15.

Meigs and Rhea Counties.—Same provisions about foxes as in Blount, but also sale of the animals or their pelts is prohibited.

Smith County.—Open season for trapping fur animals, October 15 to February 15.

Warren County.—Open season for opossum, raccoon, and other fur animals, November 1 to February 28 (29).

TEXAS.

Open seasons.—No close season for fur animals.

Trapping.—No license required for trapping, but on posted lands consent of owner is necessary.

Propagation.—Permit must be obtained from game, fish, and oyster commissioner to trap or transport wild animals for propagation purposes.

Bounties.—None paid by State.

UTAH.

Open seasons.—Beaver, otter, and marten protected at all times. If beavers destroy property, the State fish and game commissioner may give permit to kill, but hides must be delivered to the commissioner to be sold, half of the proceeds from the sale of skins of beaver so taken to be paid as compensation for trapping the animals, the balance to be paid into the game fund; possession of skins of protected fur animals prohibited unless duly tagged by commissioner. No close season on other fur animals.

Trapping.—No license required for trapping. Aliens other than homesteaders are not allowed to hunt or trap in the State.

Propagation.—No legislation.

Bounties.—Wolf, $62.50; bear, mountain lion, or cougar, $30; coyote, $4; lynx, or bobcat, $3. Fund raised by direct appropriation and a tax of 4 mills on live stock.

VERMONT.

Open seasons.—Mink, otter, and muskrat, November 1 to April 30; marten, raccoon, fisher, and skunk, October 20 to March 31; fox, October 20 to April 1 (may be taken otherwise than by trapping at any time). No open season for beaver.

Trapping.—License is required for trapping, except on one's own land; fee, resident, 60 cents; nonresident, $10.50. Persons trapping on inclosed lands of another must inform owner of location of traps and must visit traps at least once in 24 hours. The use of spring guns is prohibited, and bear traps must be carefully safeguarded. Skins of fur animals legally taken may be bought or sold at any time. Unlawful to open or destroy a muskrat house or to place a trap at its entrance. Unlawful to dig skunks from dens or to drive them out by use of smoke or chemicals.

Propagation.—The State fish and game commissioner issues special permits for propagating fur and game animals (fee, $2 and expense of tagging). Animals bred on fur farms may be sold and transported alive at all times when bearing the identification tags prescribed by the commissioner.

Bounties.—Black bear taken between May 1 and November 1, $10; hedgehog (porcupine), 15 cents; paid by State. Towns pay $5 bounty on bay lynx or bobcat.

Local laws:

Shores of Lake Champlain in Rutland County, Poultney River below Carvers Falls, and shores of Lake Memphremagog in Orleans County.—Open season for mink, muskrat, or otter, January 1 to April 30.

VIRGINIA.

Open seasons.—(Applies to any county adopting the law.) All fur animals on lands of another, noon of October 15 to noon of January 15.

Trapping.—The following applies to any county after adoption by the board of supervisors: Trapping for fur animals on lands of another is unlawful except from noon of October 15 to noon of January 15, and then is lawful only with written permission of landowner, which permission the trapper must have on his person when trapping. He must visit traps at least once in 36 hours and is liable for any damage such traps may do to domestic animals. Landowner may trap or kill fur animals on his own lands at any time.

Propagation.—License required (fee, $25) to raise game or fur animals.

Bounties.—Boards of supervisors of counties are authorized to pay a bounty of 50 cents each for goshawk and cooper's hawk.

Local trapping regulations.—The following provisions are in force:

Culpeper County.—Unlawful in Jefferson magisterial district to trap foxes except in November and December. Traps set for foxes must be visited daily to release any dog that may be caught.

Fauquier and Loudoun Counties.—Unlawful to take foxes April 1 to August 31, except by owner or tenant of land to protect property. Unlawful in open season to shoot, trap, or poison foxes except on written authority of a landowner.

Fauquier County.—Supervisors may pay 50 cents bounty on goshawk and cooper's hawk, from surplus derived from dog tax.

Halifax County.—Opossum, open season, October 15 to January 31.

King George County.—Muskrat, open season, December 20 to March 31.

Loudoun County.—License (fee, $2.50) required to trap mink, muskrat, skunk, opossum, and raccoon on lands of another. Open season for mink, muskrat, and skunk, November 1 to February 29; for opossum and raccoon, October 1 to February 29.

Nansemond County.—Mink, otter, and muskrat, open season, January 1 to March 31.

Patrick County.—Wild raccoon or opossum, open season, October 15 to March 14; gray fox, September 15 to March 14.

Princess Anne County.—Unlawful to catch, trap, or kill mink, muskrat, or otter for profit, except from November 1 to March 14.

Rappahannock County.—Unlawful to trap or hunt on lands of another without written permit from owner.

Rockingham County.—Bounty on crows authorized.

Amherst, Essex, King George, and *Loudoun Counties* are authorised to pay bounty of 50 cents each on certain hawks.

WASHINGTON.

Open seasons.—Bear, September 1 to May 1; at any time when found destroying domestic animals (1917, ch. 164). No open season for beaver. No closed season for other fur animals.

Trapping.—Trapping license (fee, $5) required. No steel trap larger than No. 4 may be used unless a notice in the English language on a large placard is placed above the trap; this requirement does not apply to trapping coyotes, muskrats, minks, skunks, martens, civet cats, and weasels.

Propagation.—Breeder's license (fee, $10; renewal, $5) required.

Bounties.—Mountain lion or cougar, $20; lynx or wildcat, $5; coyote, $1; timber wolf, $15; seal or sea lion in Columbia River district, $3; paid by State. Counties are permitted to pay additional rewards for destroying these animals, and also bounties on bear, muskrat, and squirrel.

WEST VIRGINIA.

Open seasons.—Red fox, raccoon, mink, and skunk, November 1 to February 1. Any county may by majority vote provide a perpetual close season on skunk.

Trapping.—Hunting license is required for trapping; fee, resident, $1; nonresident, $18. An owner of lands or his agent or tenant may hunt or kill protected fur animals on such lands at any time, but it is unlawful to set or maintain a snare or trap upon lands of another without express permission of owner or tenant. Unlawful to set a steel or spring bear trap on lands of another.

Propagation.—No restriction on possession or sale, but animals may not be taken for breeding purposes in close season except on lands owned or tenanted by the breeder.

Bounties.—Wildcat, bobcat, or catamount, $5; crow, 10 cents; certain hawks and owls, 25 cents; paid from forest, game, and fish protection fund.

WISCONSIN.

Open seasons.—Beaver in Price, Rusk, and Sawyer Counties, February 1 to March 31 (1919 and 1920); black bear, November 10 to December 1; fisher, marten, mink, and skunk, November 15 to February 1; raccoon, October 15 to January 1 (except Marathon County, August 15 to January 1); bag limit 5 a day; muskrat, in Polk, Barron, Rusk, Price, Lincoln, Langlade, Forest, Marinette, Florence, Iron, Oneida, Vilas, Ashland, Washburn, Sawyer, Burnett, Douglas, and Bayfield Counties, October 25 to April 20; in Calumet, Manitowoc, and Sheboygan Counties, March 1 to April 15; in remainder of State, October 25 to April 10.

Trapping.—License required for trapping; fee, resident, $1; nonresident, $25; report required from licensed trapper. Unlawful to take fisher, marten, mink, or muskrat with the aid of spear, gun, or dog; to take rabbit with ferret; to disturb or molest muskrat houses, or beaver houses or beaver dams, or raccoon den trees for the purpose of capturing raccoons; or to set traps within 500 feet of any beaver dam or beaver house. Steel traps may be used for taking fur animals in open season. The possession of green skins of any fur-bearing animal during close season is unlawful, as is also the possession at any time of the skin of a fisher, marten, mink, or muskrat which shows that the animal had been shot or speared.

Owners or lessees of dams may at any time destroy muskrats to protect such dams or levees, but they may not sell, barter, or give away the skins of such animals killed during close season.

Beavers and otters are protected at all times except beavers in 3 counties. If beavers damage property, they may be captured and removed under the direction of the State conservation commission.

Propagation.—Under permit and supervision of the commission wild animals may be taken and transported for propagation within the State. Special license required for muskrat farming (fee, $5, and 1 cent per acre for all premises in excess of 500 acres covered by the license).

Bounties.—Wolf cub taken between March 1 and November 1, $4; mature wolf killed at any time, $10; fox, $2; paid by county. County boards may increase these rewards, but no county may pay more than $6 for killing a wolf cub. The State treasurer duplicates all county awards, thus doubling the above bounties. Poisons may be used for destroying animals for bounty between December 1 and March 1, but notice of putting out baits must be posted, and they may not be placed within 80 rods of a dwelling house. County boards may offer bounty on crow, hen hawk, pocket gopher, streaked gopher, English sparrow, blackbird, or rattlesnake.

WYOMING.

Open seasons.—No close season on fur-bearing animals except beavers, which may not be taken at any time until March 15, 1925, but if they damage real estate the owner may destroy them upon making affidavit to State game warden. Skins of beaver so taken may be possessed when duly tagged by warden.

Trapping.—Unlawful to trap game animals or birds or to use their flesh as trap bait for predatory animals. Unlawful to trap on State game preserves without permit (fee, $3), and for anyone not employed by the United States Department of Agriculture to trap in national forests within the State without first obtaining a permit (fee, $3) from the State game warden. Nonresident of State must secure a special license (fee, $10) to hunt, pursue, or kill bears, but bears may not be trapped under this license. Dog license (fee, $1 for each dog) required for hunting predatory animals on national forests during close season on big game.

Propagation.—No legislation.

Bounties.—None paid by State.

LAWS OF CANADA.

ALBERTA.

Open seasons.—Mink, fisher, and marten, November 1 to March 31; otter and muskrat, November 1 to April 30. No open season for beaver until December 31, 1920, unless locally by order of the lieutenant governor in council.

Trapping.—Nonresident requires license to trap; fee, $25. Unlawful to use poison for taking fur-bearing animals; to destroy, partially destroy, or leave open any muskrat or beaver house; or to destroy a beaver dam, unless authorized to do so by the lieutenant governor in council, who may also authorize the killing of beavers or other fur animals when such killing is deemed to be in the public interest. Export of unprime skins or pelts is forbidden, unless by permit from the minister of agriculture. No fox may be trapped or taken alive for export. Every company, firm, or person engaged in the fur trade must make annual returns of the number of skins bought or sold.

Propagation.—Manager of fur farm required to make reports January 1 and July 1 of each year. Export of live animals from fur farms allowed only on permit from the minister of agriculture. Permit, with fees, required to export live muskrats, minks, fishers, martens, otters, or beavers, whether raised on a fur farm or otherwise (orders in council).

Bounties.—The council of any rural municipality is authorized to offer a bounty on wolves.

BRITISH COLUMBIA.

Open seasons.—Bear, September 1 to June 30, except that bear may not be trapped in that part of the Province lying south of the main line of the Canadian Pacific Railway; fox, November 1 to March 15; beaver, no open season; all other fur animals, November 1 to April 30. (See regulations of lieutenant governor in council, dated Aug. 7, 1919, which may be obtained from secretary, game conservation board, Victoria, British Columbia.)

Trapping.—License required to trap off one's own lands; fee, resident only, $10. A licensed trapper who first occupies a trap line prior to November 14 is protected against other trappers. License must be returned within two months after it expires, with a statement of number of fur animals of each kind taken. It is unlawful to touch or interfere with traps set by a licensed trapper, to trap on inclosed or cultivated land without permission of owner, or to permit traps to remain set after close of season. Possession or export of pelts is allowed only during open season and for two months thereafter (three months, north of fifty-second parallel), except by special permit. Special license to hunt bears from January 1 to July 1 (fee, $25, and additional fee of $15 to $25 for each bear killed) is required of a nonresident.

Propagation.—A permit to propagate fur-bearing animals is required. Breeder must keep a record of transactions as to purchases and sales of stock, which record must be open to inspection of any game warden. Live foxes may be exported only under permit. Permit is required to take foxes or other fur animals in close season.

Bounties.—Rates fixed from time to time by lieutenant governor in council.

MANITOBA.

Open seasons.—South of fifty-third parallel: Fisher, pekan, sable, marten, and mink, November 1 to March 31; otter and beaver, no open season; fox and lynx, no close season. *North of fifty-third parallel:* Fisher, pekan, sable, marten, and mink, November 1 to March 31; otter and beaver, November 1 to April 30; fox and lynx, November 1 to February 29.

Muskrat, *south of fifty-first parallel:* March 1 to May 15; *north of fifty-first parallel:* October 20 to November 30, and March 1 to May 15. Unlawful to shoot or spear muskrats.

Trapping.—A license is required to trap, fee, resident, $2; nonresident Canadian citizen, $25; nonresident alien, $100. Report giving number of animals of each kind taken under license is required to be made between June 1 and

July 1. Persons trading in furs must be licensed (fee, resident $10; nonresident, $50) and are required to make annual returns before September 30. Unlawful to trap in Provincial game preserves, to trap on cultivated or inclosed lands without permission of owner, to destroy a muskrat or beaver house, to use poison in taking fur animals, or to export unprime skins. Poison may not be used to capture wolves for bounty.

Propagation.—No legal restrictions except that a special permit must be obtained to export live fur animals; fee for black or silver fox, $100; for other fox, $15; for live otter, $25; for any other fur animal, $5.

Bounties.—Timber wolf, $5; other wolf, $2; half is refunded to municipality by the Provincial treasurer.

NEW BRUNSWICK.

Open seasons.—Mink, otter, and fisher, November 1 to March 31; fox, October 1 to March 1; muskrat, noon of March 25 to noon of May 15. Beaver and sable, close season to July 1, 1920. The Minister of Lands and Mines, when satisfied that a number of beavers may be taken from any stream without injury to the supply, may issue a special license accompanied by necessary tags, for taking them; fee, $4 for each animal.

Trapping.—Nonresidents require a license (fee, $25) for trapping. A license is also required to deal in, buy, sell, cure, or tan the skin of fur-bearing animals, (fees, nonresident, $25; resident, $2). The digging out of foxes from their homes or earth burrows is prohibited at all times. Unlawful to possess green skins or carcasses of protected fur animals in close season.

Propagation.—Permits to capture wild fur-bearing animals for propagation within the Province may be obtained from the Minister of Lands and Mines, who fixes the fee for such permit.

Bounties.—Wildcat (killed within the Province), $3; porcupine, 50 cents: hawks and owls, 25 cents each; paid by the Minister of Lands and Mines.

NORTHWEST TERRITORIES.

Open seasons.—Mink, fisher, and marten, November 1 to March 14; otter, beaver, and muskrat, October 1 to May 14; white fox, November 15 to March 31. Trapping prohibited on Victoria Island.

Trapping.—License required of all trappers except native Indians; fee, resident, $2; nonresident, British subject, $25; other nonresident, $50. Licensed trapper may sell or trade the skins of animals he has legally taken. License (fee, $5) required for trading or trafficking in furs. Unlawful to destroy or injure any beaver or muskrat house. Use of poison prohibited in taking fur animals. Export of unprime or low-grade furs forbidden.

Propagation.—Permits may be obtained to take live fur animals for propagation.

Bounties.—Timber wolf, $20.

NOVA SCOTIA.

Open seasons.—No open season for beaver or marten. Mink, otter, fox, raccoon, muskrat, and all other fur-bearing animals (except bear, wolf, and wildcat, which are not protected), November 1 to January 31.

Trapping.—Nonresident requires a license (fee, $30) to take fur-bearing animals, which are included in the term "game." Unlawful to take any protected fur animal (unless under a permit) from a burrow or den by smoking or digging; to take fur animal by use of poison; to damage or molest a beaver dam or house, or a muskrat house, or set snare or trap within 25 feet of the latter; or to have in possession the green hide or pelt of a fur animal taken out of season.

Propagation.—Permits to take wild animals may be obtained from the board of game commissioners under such restrictions as they may require. Unlawful to keep fur-bearing animals in captivity for breeding purposes without a permit from the chief game commissioner; fee $2 for each kind of animal kept, payable annually. Reports are required annually on September 30. Inclosures for fur animals are protected from trespass.

Bounties.—None paid.

ONTARIO.

Open seasons.—Mink, fisher, and marten, November 1 to April 30; muskrat, north of French and Mattawa Rivers, April 1 to May 20; south of said rivers, March 1 to April 20. Beavers and otters may be taken by residents of the Province only, under license and special restrictions, from November 1 to March 31.

Trapping.—License to trap required except to take wolf and fox or for farmers and their sons to trap on own land; fee, resident, $5; nonresident, $50. License (fee for resident and British subject, $10; for alien, $25) is required of all fur dealers or traders. Dealers may obtain a permit to hold furs during close season. Possession of unprime skins is illegal. Muskrats may not be shot or speared at any time. Muskrat houses are protected at all times except when the animals are injuring property. Beavers, when damaging property, may be destroyed by game overseer under special authorization from the department of game and fisheries.

Propagation.—A permit is required of breeders of game or fur animals. Licensed fur breeders may sell live animals or skins during open season upon payment of royalties. The Minister may grant permits to take fur animals during the close season for propagating and scientific purposes.

Bounties.—Gray timber wolf, $20; other wolf, $5; paid by county, but Provincial treasurer refunds 40 per cent to county. Provincial treasurer pays entire bounty in unorganized counties.

PRINCE EDWARD ISLAND.

(1919 laws not received.)

Open seasons.—Marten, mink, muskrat, and otter, November 1 to March 31; beaver, no open season, and the animals or their pelts taken in the Province may not be sold.

Trapping.—Nonresident requires license (fee, $50) for trapping. Unlawful to put out poisoned baits for foxes or other animals.

Propagation.—Several special acts of the Provincial legislature regulate fox ranching on the island. The animals are assessed for taxation; ranches are protected from trespass, under heavy penalties; and incomes from ranches are taxed.

Bounties.—None paid.

SASKATCHEWAN.

Open seasons.—Mink, fisher, and marten, November 1 to March 31; otter and muskrat, November 1 to April 30; fox, north of township 50, November 1 to March 31; beaver, December 1 to April 30 (except on game preserves and where protected by municipality).

Trapping.—Nonresident requires license (fee, $25) to trap. Unlawful to trap on game refuges or on inclosed or cultivated lands of another without consent of owner or occupant; to use poison for taking fur animals; to spear or shoot muskrats, or to destroy muskrat houses; to buy, sell, ship, or possess unprime furs; to buy or sell furs without license (fees, residents north of township 25, $10; south of township 26, $2; nonresidents, $25); and to ship any fur animal in concealed receptacle. Licensed fur traders must make annual report of operations.

Propagation.—Permit required (fee, $1 annually) to operate a fur ranch. Permit to ship live fur animals is required; fee, for black or silver fox, $25; for cross or red fox, $5; for other fur animal, $5. Young foxes may not be taken from dens before May 15.

Bounties.—Adult timber wolf, $10; pups of prairie or timber wolf, $1; paid only in properly gazetted wolf districts, when half is refunded from Provincial treasury.

QUEBEC.

Open seasons.—Mink, otter, marten, fisher (pekan), raccoon, skunk, or any other fur-bearing animal not excepted in this article, November 1 to March 31; beaver, November 1 to March 31; muskrat, March 15 to April 30; fox, November 1 to February 29; bear, August 20 to June 30.

Trapping.—Use of poisons in taking fur animals prohibited. Reports are required of all persons engaged in the fur trade (buying, selling, or taking fur animals) before September 1 of each year. Royalties must be paid on fur animals or furs shipped out of the Province.

Propagation.—The minister of colonization, mines, and fisheries may grant permits to take animals alive for breeding purposes; nonresidents are charged a fee of from $5 to $25 for such license.

Bounties.—Wolf, $15.

YUKON.

Open seasons.—Beaver protected at all seasons. No close season for other fur animals, except young foxes; these may not be taken from April 1 to May 31. Unlawful to export raw furs from territory except under permit issued by direction of the commissioner, and upon payment of the export tax.

Trapping.—Use of poison in taking animals forbidden.

Propagation.—No restrictions other than as to foxes. Registration of fox breeders required. Unlawful to export a fox not born in captivity or which has been in captivity for less than a year; any fox born in captivity may be exported under a permit (fee, $5). Fox and other fur ranches, if posted against trespass, may not be approached without owner's consent.

Bounties.—None paid.

LAWS OF NEWFOUNDLAND.

Open seasons.—Otter, marten, and lynx, October 1 to March 31; fox, October 16 to March 14; muskrat, October 1 to April 30. No open season for beaver until October 1, 1920.

Trapping.—Nonresident trappers require annual license; fee, $501. Fur buyers and shippers also require annual license (fee, 50 cents), and must report operations under same before December 31 of each year. Trapping on Grand Lake Caribou Preserve is unlawful at all times.

Propagation.—No restrictions, except as to foxes. A fox farm must be licensed; the owner must at stated times make reports to the game and inland fisheries board, and the premises must be at all times open to inspection by officers of the board. Possession of fox cub or fox taken in close season is prohibited. Unlawful to export a fox not bred on a fox farm, or, without permit from the colonial board, to export a fox bred in captivity.

Bounties.—None paid.

OFFICIALS FROM WHOM COPIES OF LAWS RELATING TO FUR-BEARING ANIMALS MAY BE OBTAINED.

Alabama: State game and fish commissioner, Montgomery.
Alaska: The governor, Juneau; Secretary of Commerce, Washington, D. C.
Arizona: State game warden, Phoenix.
Arkansas: Secretary, game and fish commission, Little Rock.
California: Executive officer, fish and game commission, New Call Building, San Francisco.
Colorado: State game and fish commissioner, Denver.
Connecticut: Secretary, commission of fisheries and game, Hartford.
Delaware: Chief game warden, Dover.
District of Columbia: Superintendent Metropolitan Police, Washington.
Florida: Secretary of state, Tallahassee.
Georgia: Game and fish commissioner, Atlanta.
Idaho: Fish and game warden, Boise.
Illinois: Chief game and fish warden, Springfield.
Indiana: Director, Department of Conservation, Indianapolis.
Iowa: State fish and game warden, Lansing.
Kansas: State fish and game warden, Pratt.
Kentucky: Executive agent, game and fish commission, Frankfort.
Louisiana: Commissioner of conservation, Court Building, New Orleans.
Maine: Commissioner of inland fisheries and game, Augusta.
Maryland: State game warden, 512 Munsey Building, Baltimore.
Massachusetts: Chairman, commissioners of fisheries and game, State House, Boston.
Michigan: Commissioner game, fish, and forest-fire department, Lansing.
Minnesota: Game and fish commissioner, St. Paul.
Mississippi: Secretary of state, Jackson.
Missouri: Game and fish commissioner, Jefferson City.
Montana: State game warden, Helena.
Nebraska: Chief deputy, game and fish commission, Lincoln.
Nevada: State fish and game warden, Carson City.
New Hampshire: Fish and game commissioner, Sunapee.
New Jersey: Secretary, board of fish and game commissioners, Trenton.
New Mexico: Game and fish warden, Santa Fe.
New York: Secretary of conservation commission, Albany.
North Carolina: Secretary, Audubon Society of North Carolina, Raleigh.
North Dakota: Secretary, game and fish board, Steele.
Ohio: Chief game warden, board of agriculture, Columbus.
Oklahoma: State game warden, Oklahoma City.
Oregon: State game warden, Portland.
Pennsylvania: Secretary, board of game commissioners, Harrisburg.
Rhode Island: Chairman, commissioners of birds, Rumford.
South Carolina: Chief game warden, Columbia.
South Dakota: State game warden, Pierre.
Tennessee: State game and fish warden, Nashville.
Texas: Game, fish, and oyster commissioner, Austin.
Utah: Fish and game commissioner, Salt Lake City.
Vermont: Fish and game commissioner, Cambridge.
Virginia: Commissioner of game and inland fisheries, Richmond.
Washington: Chief game warden and State fish commissioner, Seattle; chief deputy game warden, Spokane.
West Virginia: Forest, game, and fish warden, Philippi.
Wisconsin: Secretary, conservation commission, Madison.
Wyoming: State game warden, Lander.

CANADA.

Alberta: Chief game guardian, Edmonton.
British Columbia: Secretary, Game Conservation Board, Victoria.
Manitoba: Chief game guardian, Winnipeg.
New Brunswick: Chief game and fire warden, Richibucto.
Northwest Territories: Commissioner of Parks, Ottawa.
Nova Scotia: Chief game commissioner, Halifax.
Ontario: Superintendent game and fisheries, Toronto.
Prince Edward Island: Game inspector, Charlottetown.
Quebec: General inspector of fisheries and game, Quebec.
Saskatchewan: Chief game guardian, Regina.
Yukon: Gold commissioner, Dawson.
Colony of Newfoundland: Secretary, department of marine and fisheries, St. Johns.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO FUR-BEARING ANIMALS.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

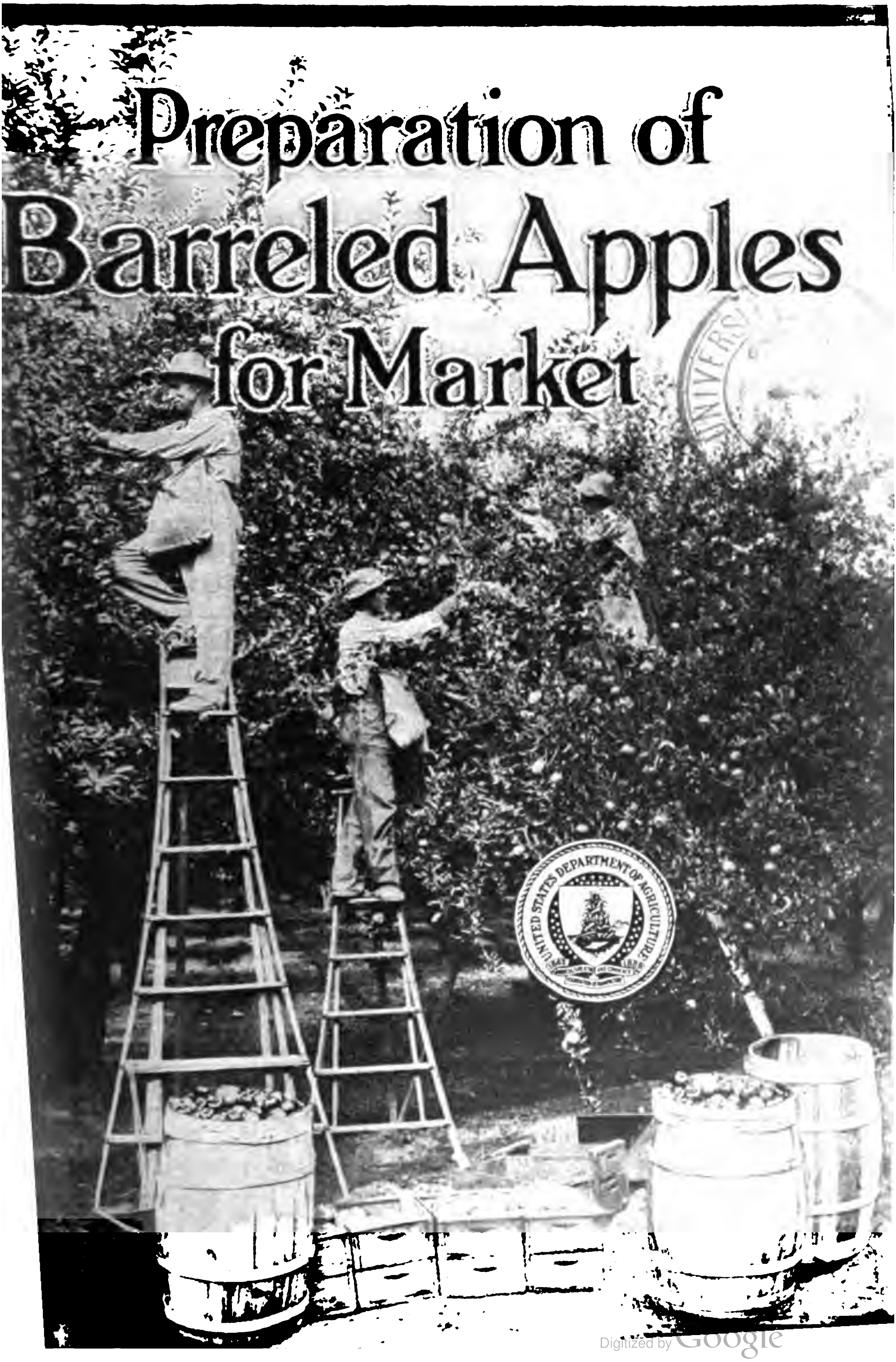
Raising Belgian Hares and Other Rabbits. (Farmers' Bulletin 496.)
The Common Mole of Eastern United States. (Farmers' Bulletin 583.)
Economic Value of North American Skunks. (Farmers' Bulletin 587.)
The Domesticated Silver Fox. (Farmers' Bulletin 795.)
Trapping Moles and Utilizing Their Skins. (Farmers' Bulletin 832.)
The Muskrat as a Fur Bearer. (Farmers' Bulletin 869.)
Fur Farming as a Side Line. (Yearbook Separate 693.)
Annual Report of the Governor of Alaska on the Alaska Game Law, 19[illegible] (Biological Survey Document 110.)
Directory of Officials and Organizations Concerned with the Protection of Bir[illegible] and Game, 1919. (Department Circular 63.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRIN[illegible] OFFICE, WASHINGTON, D. C.

Deer Farming in the United States. (Farmers' Bulletin 330.) Price, 5 ce[illegible]
The Muskrat. (Farmers' Bulletin 396.) Price, 5 cents.
Raising Deer and Other Large Game Animals in the United States. (Biolo[illegible] Survey Bulletin 36.) Price, 15 cents.

FARMERS' BULLETIN 1080
UNITED STATES DEPARTMENT OF AGRICULTURE

Preparation of Barreled Apples for Market



UNIVERS

A NEW INTEREST in commercial apple growing has been awakened in the East and Middle West, caused in a measure at least by the comparative nearness to the large markets and the correspondingly low freight rates, by the relatively low cost of orchard land, and by the satisfactory prices which have been obtained in recent years for properly graded fruit. This interest has found expression in the erection of modern packing houses, in the increasing demand for labor-saving equipment, and in more careful grading and packing. There is still, however, a great need for orchardists to study the various operations involved in moving the crop from the orchard to the market in order to reduce the cost of handling and to raise the general standard of the barreled apple industry. This bulletin will provide growers with a basis for comparing their own methods with those employed successfully in representative orchards throughout the country.

Contribution from the Bureau of Markets
GEORGE LIVINGSTON, Acting Chief
Washington, D. C. September, 1919

PREPARATION OF BARRELED APPLES FOR MARKET

W. M. Scott, *Specialist in Fruit Grading and Standardization;* H. C. Hetzel, H. W. Samson, and M. Stockton, *Investigators in Marketing Fruits and Vegetables.*

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THE COMPETITION of an increasingly large tonnage of carefully graded boxed apples has resulted in a more exacting market and has emphasized the importance of the closest study of the details of operation and equipment in the marketing of barreled apples. Well-chosen equipment, up-to-date methods, and careful supervision of crews must supplant the haphazard methods which prevail to some extent in all producing sections.

HARVESTING.

In making inspections of apples on the market during the course of the investigations on which this bulletin is based, special attention was given to the stage of maturity and its relation to the market value of the fruit. A large amount of fruit reaching the market each season is greatly impaired in quality by being picked at the wrong stage of maturity, either too early or too late. This mistake is caused both by a misunderstanding on the part of many growers as to when the fruit should be picked, and by the failure to interpret correctly under field conditions the factors indicating the proper stage of maturity.

Well-informed growers are often careless in the observance of the proper picking time, permitting other farm work, the condition of the market, or other factors to postpone the harvest.

TIME OF PICKING.

Varietal characteristics, seasonal variations, cultural practices, and other factors affect the maturity of apples, and it is difficult to lay down any fixed rules to determine the proper stage for harvesting. There are, however, certain indications of ripeness, such as red color,

color of the seeds, and the ease with which the stems separate from the spurs. These will enable any grower with some practice to recognize the proper stage.

The amount of red color is usually the basis for judging the time of picking red and striped varieties; in a majority of cases normally colored fruit of such varieties is ready to harvest if it has attained the proper size and separates readily from the spurs. Fruit is not ready to pick when it clings to the spurs so tightly that the stems are pulled out or the spurs broken.

Red color, however, is not always a reliable index, as the amount of color varies with the season, the size of the crop, the vigor and age of the tree, soil conditions, and other factors. For example, in years when bright days and cool nights come early in the season the fruit will color before reaching full size and maturity; while on the other hand, in seasons of warm cloudy weather, the crop may become overripe without the normal amount of color. Frequently a crop of pale fruit is allowed to hang so long in an attempt to secure good color that it is harvested in an overripe condition.

Whether or not the red color develops normally, a reliable indication of maturity is the ground color, which, when the fruit is ready for picking, should be turning from the clear green indicating immaturity to a whitish or greenish yellow.

With yellow, green, and russet varieties color can not be used to determine maturity. Such varieties are generally ready to pick when they have attained the proper size and the stems separate readily from the spurs. It is generally believed that the brown color of the seeds indicates full maturity, but this is not a reliable index, as it is very common to find colored seeds in immature fruit. It is certain, however, that the fruit is not ready to pick before the seeds turn brown.

Fruit that is harvested in an immature condition is inclined to scald in storage and in extreme cases may shrivel; on the other hand, if it is allowed to become overripe on the trees, the length of time it will keep in storage is reduced greatly. Some varieties when overripe crack in the blossom end and many drop badly. The grower must study each variety to get the best results in storage and in the market. An exception must be made in the case of summer apples, as they are not intended for storage. In order that these varieties may be permitted to ripen fully, it is a common practice in certain sections to mulch the ground under the trees quite heavily with straw and to allow them to drop rather than to pick them. It is also customary to thin out the larger apples of later varieties for cooking purposes as soon as they become large enough to meet the demands of the market.

NUMBER OF PICKINGS.

Most growers in all sections remove all of the fruit from the trees at one picking. Many, however, make two or more pickings during the season, especially when the fruit is not uniformly of good color, but is otherwise of high quality. The advisability of making more than one picking depends upon the extent to which the size and color of the fruit are affected by the load. The apples on the outside of the tree, especially the larger and better-colored specimens, are removed by the first picking to permit the limbs to lift and expose the uncolored fruit to the sun. This thinning also tends to bring about an increase in size of the fruit remaining on the trees. In the course of a week or ten days the second picking is made, when the remainder of the crop usually is removed. In a very few instances more than two pickings are made.

Two pickings are more expensive than one because of the additional time required to remove the fruit in this way, though the increase in the market value of the crop often justifies this practice. Again, if the crop is of low quality because of various blemishes, the value of the fruit usually is not sufficient to warrant the extra cost of more than one picking.

METHOD OF PICKING.

In picking apples the stem should be separated from the spur either by giving the fruit a slight rotating motion combined with a sharp upward twist or by exerting a slight pressure with the thumb or forefinger at the joint of the stem and spur, just as the fruit is pulled. The stem should not be torn out, as apples which are injured in this way are more subject to decay in storage.

If twigs or spurs are pulled off with the fruit they are likely to cause stem punctures during the hauling and packing operations. Also, because fruit is borne on the same spurs year after year, subsequent crops may be reduced. Some varieties lose their spurs very readily even where reasonable care is exercised by the pickers, but growers should insist that these spurs be removed from the fruit before it is placed in the picking receptacle even if the speed of the work is reduced. Satisfactory results are seldom obtained unless the work of each picker is inspected from time to time by the grower or a competent foreman.

PICKING UTENSILS.

Canvas sacks of various kinds and half-bushel baskets of the round type are used almost exclusively as picking receptacles for apples. In recent years the use of the picking sack has increased very rapidly, until now it shares equally in popularity with the basket.

It is generally advantageous to use both in removing the crop, as baskets are especially convenient for gathering fruit near the ground, while sacks can be used to advantage only when the picker maintains an upright position. Hamper baskets serving as picking utensils are encountered in the Delaware and New Jersey apple sections, where they are used extensively. Tin buckets with drop bottoms of canvas and several other patented receptacles designed to facilitate the emptying process are much used in certain localities, and ordinary metal buckets are used to a very limited extent.

Picking sacks vary widely in design and in the material used in making them. In the Potomac Valley region and in Virginia, many growers are employing a homemade sack of burlap which holds about three-fourths of a bushel. These sacks can be made easily and quickly from a burlap bag with comparatively no expense, and for this reason are employed by some growers in all sections; but, because such bags must be inverted to be emptied, which usually increases the amount of bruising, they are generally recognized as less desirable than the drop-bottom type. At the same time they may be used without appreciable injury to the crop if the fruit is of generally low quality or if of a variety not easily bruised, such as the Ben Davis.

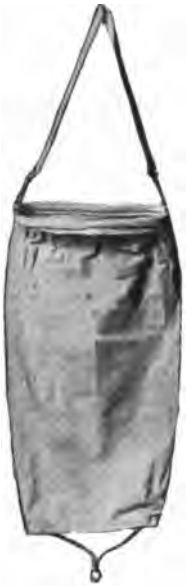

FIG. 1.—Drop-bottom canvas picking sack.

The drop-bottom canvas sacks (fig. 1) holding about one-half bushel are equipped with straps that fasten them securely in front of the body and hold them in place as the picker is working from the ladder. The sack consists of a canvas tube held open at the top by a wire frame. The bottom of the tube is equipped with a snap or with rings so that the sack may be closed by folding up the tube and attaching it to a ring or hooks, as the case may be, on the front of the bag. These sacks are more convenient than baskets because they are held in place in such a way that pickers have free use of both hands. For this reason they can be used to good advantage where speed is an important consideration. Their chief disadvantage lies in the greater possibility of bruising the fruit as the picker walks about or presses the sack against the ladder or branches.

Another type of canvas sack has the opening in front but hangs under the picker's arm. This construction enables the picker to descend from the tree without bumping the fruit into the ladder.

Round half-bushel picking baskets (fig. 2), used in all of the eastern apple-growing sections, usually are made from staves, and are equipped with wire bails or wooden handles. The rigid sides of these baskets protect the fruit from perssure, and in harvesting tender varieties this feature is essential. Pickers have a tendency when using baskets to place them in a crotch of the tree or to hook them over a limb, and then toss the fruit into them from a distance of several feet, causing severe bruises and often broken skin. If the baskets are padded or lined with corrugated paper the fruit will be protected to a considerable extent from such injury. Where ladder work is being done the baskets should be fitted with an S-shaped hook that enables the picker to move them frequently and use both hands for picking.

The proper method of emptying baskets or sacks should be impressed repeatedly upon the picker's mind. In emptying either, care should be exercised to avoid dropping the fruit. For example, if baskets are emptied into lug boxes the basket should be lowered to the bottom and inverted gently, or the lug box should be tipped so that the fruit rolls directly from the basket down the side as shown in figure 2. Drop-bottom sacks are so constructed that fruit can be emptied without bruising if the bottom of the sack rests on the bottom of the container when it is opened.

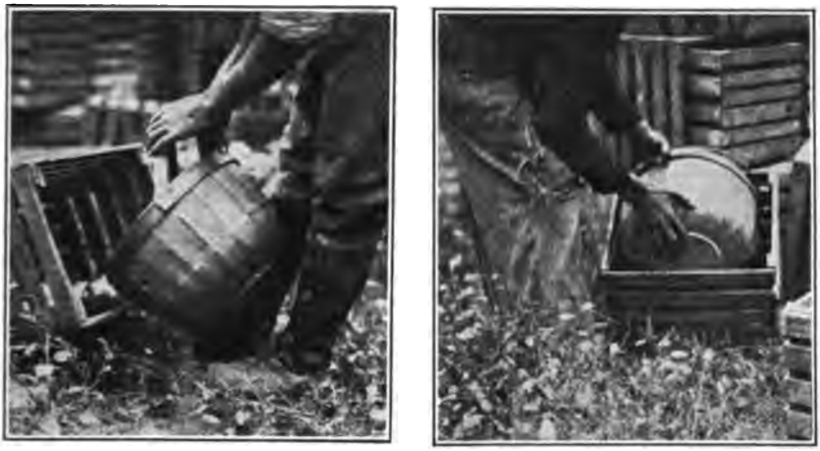

FIG. 2.—Two approved methods of emptying picking baskets into field crates.

It is evident that all of these utensils have uses to which they are peculiarly adapted, and one can not be recommended to the exclusion of the others. The successful use of any particular picking utensil is largely a matter of management, and two different types can often be used to advantage.

LADDERS.

Several different types of picking ladders are in common use. The ordinary straight ladder is still used extensively in most sections, but is being displaced rapidly by improved types. The chief disadvantage of the straight ladder is the top-heavy tendency which makes it difficult to set it securely against the smaller branches without breaking them and knocking off fruit. One desirable modification of this ladder has a broad base and tapers toward the top. This construction gives a better distribution of the weight and makes it correspondingly easy to handle.

The pointed ladder is probably most satisfactory, as it is lighter and can be placed against a limb or fork that would not support a common straight ladder. For picking in the tops of high trees, extension ladders are very desirable, as they make it possible to gather fruit which could not be reached in any other way.

The use of such ladders is preferable to having the pickers climb the trees. Climbers in heavy shoes are likely to split the crotches and peel the bark. It is generally necessary, of course, to gather part of the fruit borne in the center of the tree by climbing, and where this is done much injury to the tree may be prevented if the pickers wear rubber-soled shoes or leather shoes without heels.

Stepladders of various kinds are especially satisfactory in harvesting fruit from small trees, and from the lower branches of large trees. The most desirable types are wide and flaring at the bottom, narrow at the top, and supported with but one prop. (See front cover.) Such ladders can be " set " quickly and securely, if the ground is level, without knocking off the fruit as do the long ladders which are leaned against the trees. As a general rule not enough consideration is given to the selection of ladders best adapted to the particular requirements of the orchard.

HANDLING THE FRUIT FROM THE TREE TO THE PACKING TABLE.

Where the crop is packed over tables that are moved from place to place in the orchard the fruit usually is carried in the picking utensil to the packing table. It is common practice for pickers to carry the fruit, but in so far as possible this should be avoided because it is both expensive and inefficient. Certain members of the crew should be assigned to the task of carrying the filled baskets to the table and furnishing the pickers with empty baskets. These men carry at least two full baskets of fruit from the tree to the table, whereas the picker makes the trip with one. If picking sacks are used, the fruit is carried to the tables in lug boxes which when full are too heavy to be handled by women or boys. The carriers also save much time for the pickers who are working on ladders or in the trees by taking the full baskets which are lowered by means of a rope and attaching empty ones. This makes it unnecessary for the picker to climb down to empty his basket.

Where the packing is done at a central packing house or at one permanent location in the orchard, the fruit is delivered to that place in boxes, crates, barrels, or baskets, the kind of receptacle depending upon the locality.

Barrels are used most commonly in New England and in New York. They are also used a great deal in the middle-western States and by some growers in all sections. The use of barrels as field carriers not only makes unnecessary the expense of special orchard boxes, but also affords a package in which the fruit may be stored until it is packed. However, crates and boxes are preferable, as they are more conveniently handled and they may be stacked securely in storage or during hauling without bruising the fruit.

A very durable slatted crate which holds about a bushel is extensively used. Such a crate, illustrated in figure 3, has a solid bottom while the grooved top strips and half-round bottom strips fit together when the crates are stacked and prevent them from shifting. A majority of the different kinds of lug boxes are made by local manufacturers. The best ones holding about a bushel are made of heavy material, with hand holes at the ends and cleats across the top.

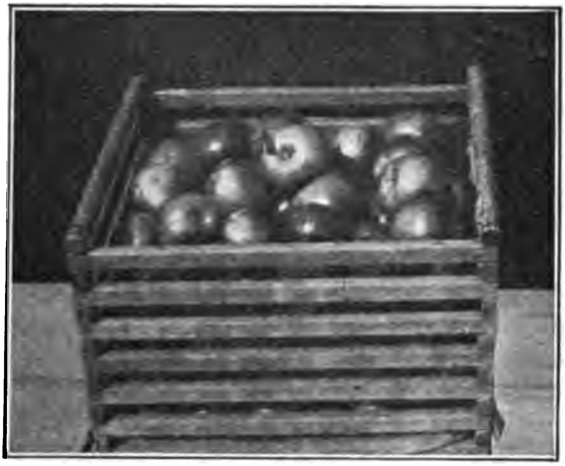

FIG. 3.—Slatted folding crate widely used as a field carrier.

Time will be saved if the pickers are at all times provided with an abundance of field crates to receive the picked fruit. The grower or foreman should see that these are distributed to the proper points in advance of the crew.

BASIS OF PAYING PICKERS.

In 90 per cent of the orchards investigated by the Bureau of Markets the growers were paying pickers on a straight day-wage basis; the remaining 10 per cent paid on the basis of the amount of fruit picked, and there are growers in all sections who are successfully employing this method. The speed of the work undoubtedly can be increased by paying the pickers on a piece-work basis.

This system may be employed advantageously where there is a labor shortage, or where there is low quality fruit, heavy dropping, or any other circumstance demanding the quick removal of the crop. It is the exceptional picker who will do his utmost when paid by the day, and the exceptional one who will not pick more when paid by the piece. The pickers generally make better wages by this plan, and any tendency toward carelessness can be avoided by strict supervision. If the grower is not able to superintend the pickers, the damage resulting from carelessness may more than offset the advantage of the increased amount picked. It is possible to check up accurately on the work done by each picker by requiring that a check bearing an identifying number be placed in each basket or box picked. If the wages are adequate and the supervision is careful enough, the piece-work system can be employed successfully in picking crops of high quality.

GRADING AND PACKING.

In small orchards under favorable weather conditions apples are usually packed in the open, portable equipment being used, but in large orchards and in sections where unfavorable weather generally prevails during the harvesting season, the fruit is more often packed in central houses, tents, or sheds.

In New England, packing operations are very generally conducted under cover, as the weather in the fall makes it necessary to harvest as soon as possible. The prevailing temperatures at this time of the year favor common storage and the packing can be extended over a considerable length of time. Consequently, the practice in this section, and to a less extent in other sections, is to pick the fruit and place it in barrels, which are stored temporarily in sheds or other outbuildings, and to pack it later. If the fruit is to be held for any length of time it should be placed under proper conditions of storage, otherwise it should be packed as soon as possible and removed to storage. In producing sections farther south the common and most desirable practice is to pack the fruit as soon as it is picked and remove it to storage as quickly as possible.

The use of packing houses has increased rapidly during recent years and constitutes a development in the right direction. They have come into use in both large and small orchards, and many growers who operate only a few acres of apple trees have their packing done in a house or shed. This practice affords the following advantages:

(1) Shelter is afforded for an accumulation of unpacked fruit and the grading and packing can be continued without interruption in spite of unfavorable weather;

(2) Equipment, packages, and fruit are protected from the weather at all times;

(3) The use of a house encourages the installation of sizing machinery and other labor-saving devices which can not be used to advantage in the open; and

(4) The efficient organization of labor is simplified by having all of the work done in one place; there is no necessity for the confusion and loss of time which is caused when the outfit is moved frequently.

The tendency among the larger and more progressive growers in all sections is toward the use of packing houses equipped with machinery. In small orchards, when the climatic conditions are especially favorable, it may be advisable to pack in the orchard, but in most instances the use of a house or shed of some sort will insure better results.

Many growers contend that packing houses are not desirable in orchards located on rough, hilly land owing to the difficulty of hauling the loose fruit. However, some of the largest and most successful houses operated at the present time are located on hilly land, and they have the advantage of avoiding the difficulties encountered where the fruit is carried to the table and the equipment is moved from place to place on steep hillsides.

Packing houses are particularly desirable under conditions such as are found in the upland orchards on the steep sides of the Blue Ridge Mountains. In some of these mountain orchards growers encounter so much difficulty in moving their packing equipment that they select a central location for their packing operations, where they remain. As a rule, where the slopes are steep there is not enough level ground available to provide sufficient room for the equipment and the various members of the crew, and as a result the packers and sorters interfere with each other and limit the general efficiency of the work. Under these conditions the matter of temporary storage for both empty and filled barrels in the vicinity of the packing tables also offers a perplexing problem. Practically all growers who have used packing houses are emphatic in their indorsement of their use as compared with orchard packing.

GRADING TABLES.

Two types of grading or sorting tables are used almost exclusively where the fruit is graded in the orchard, and they are used to a large extent in packing houses also. These are the apron table and the canvas or burlap table.

Apron table.—The apron table or a variation of this type is commonly used in all sections. The table shown in figure 4 is typical of the kind used when packing is done in the orchard. Frequently tables similar to this are equipped with wheels so that they can be moved easily about the orchard. The bed of the table, which is slatted in such a way that the trash falls through, is inclined so that the fruit as it is graded rolls to the lower end, where, upon the opening of a stop or trap, it is lowered by means of an apron into the barrel.

The end of the table where the packing is done tapers down to an opening approximately 1 foot in width. A 50 or 75 bushel hopper or bin into which the fruit is emptied directly from the orchard wagons is sometimes attached to the apron table. (See fig. 5.) This arrangement has the advantage of furnishing a continuous supply to the table and also saving handling the field containers in the packing shed. However, unless the bin is kept nearly full, the fruit is almost certain to be bruised in rolling down the necessarily steep

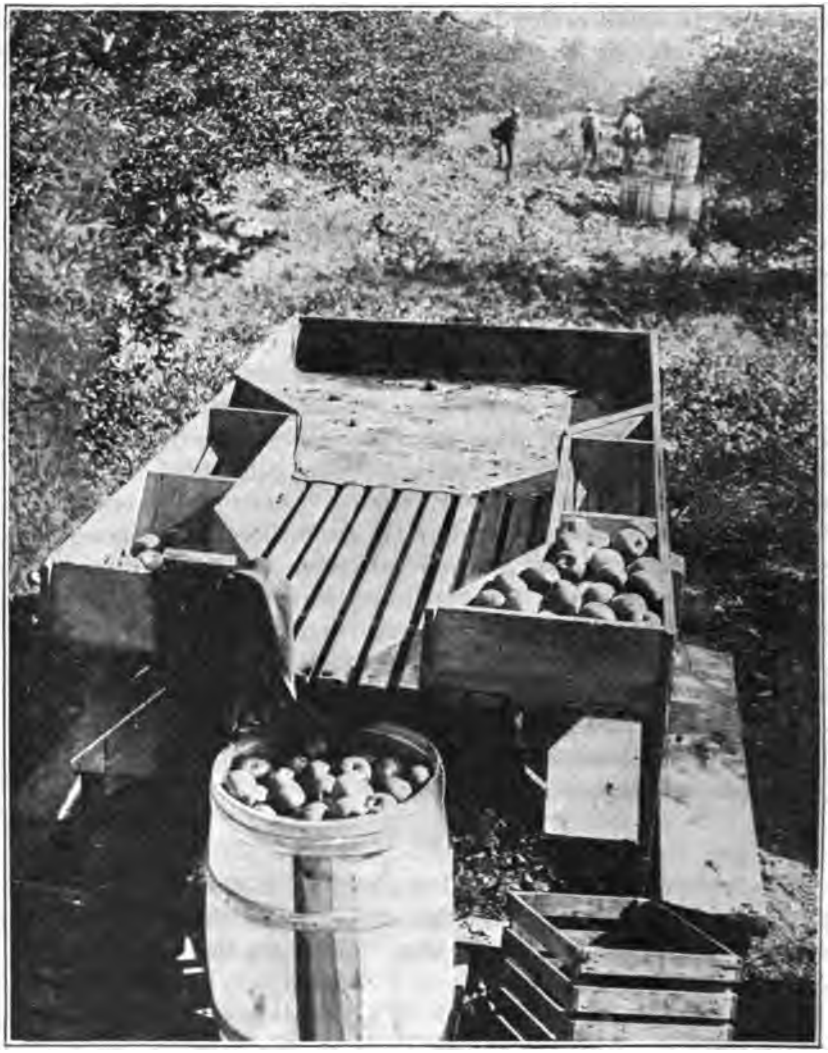

FIG. 4.—Apron grading table commonly used by barreled apple packers. The apples in the corner pockets are selected for facing fruit.

incline to the bottom. The weight of the fruit in the bin also makes it difficult to regulate the feeding and the apples often rush by the sorters faster than they can be graded properly.

The usual method where two grades are packed is to remove the culls and the second-grade fruit into baskets or barrels and to allow the first-grade fruit to "run" over the table. When one of two grades is sorted out, the sorters should always remove the grade which constitutes the smaller proportion of the fruit, in order to reduce the amount of handling to a minimum, and to allow the grade constituting the larger part to be run over the apron into the barrel. It is a mistake to run the first grade over the end of the table when this would necessitate the handling of the larger proportion of the apples. The man who packs the barrel is usually responsible for the maintenance of the grade. He has charge of the crew at his table and in addition to checking up the work, he supplements the sorting by going over the fruit as it passes into the barrel.

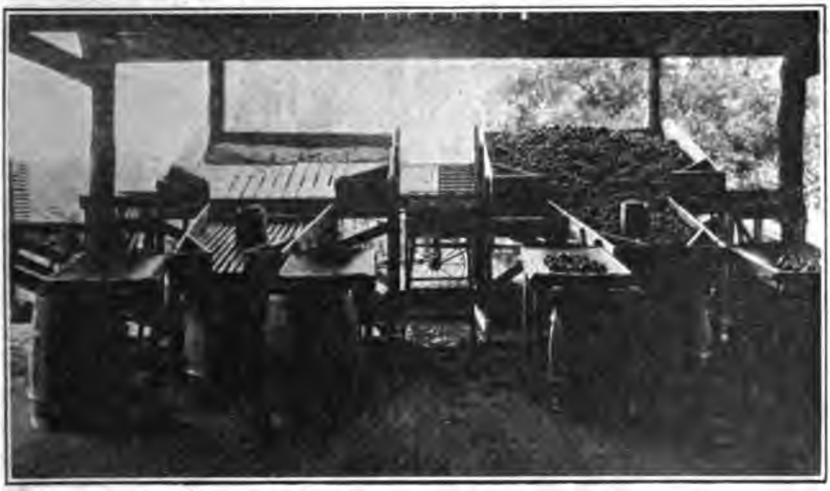

FIG. 5.—Receiving bins. The fruit is emptied directly from the orchard wagons into these large receiving bins. This provides a continuous supply to the packing tables.

This type of table is popular because the work can be done rapidly. It is not altogether satisfactory, as the fruit frequently crowds past the sorters in a way which encourages carelessness. The actual sorting takes place as the fruit is being pushed or rolled along to the end of the table which is frequently kept so full that it can not be thoroughly inspected. Only with very careful management can the grades be maintained by the use of this table, especially if the fruit is not uniformly of good quality.

Canvas or burlap table.—The second type of grading table is made of canvas or burlap stretched over a rectangular frame. It is not fitted for running the fruit over an apron into the barrel as with the apron table. The apples must be sorted by hand into baskets, in which they are lowered into the barrels. The advantage of this table is that all of the apples are subjected to careful inspection as they are removed by the sorters. Although as a rule this is a slower process than that of handling the fruit over an apron table, the sorters with practice soon become skilful and are able to handle the fruit very rapidly. When as much as half of the fruit must be removed from the apron table in the process of grading the same work could be done as rapidly and more accurately over the canvas-top table.

Care must be exercised in the management of either type if the best results are to be obtained. In the case of the apron table, the fruit is often bruised by crowding it along with the picking baskets as they are being emptied. With canvas-topped tables, the sorters should be cautioned about throwing the apples into the baskets into which the fruit is being graded. Injury from this source may be avoided to a considerable extent by padding.

SIZING MACHINES.

Sizing machines for barreled apples are gaining rapidly in popularity, although prior to five years ago the mechanical sizing of fruit for barrel packing was generally considered impractical. Machines for the sizing of boxed apples have been used in the Northwest for several years, but these operate on a different principle from that employed in barreled apple sizing machines. The most popular machines used for boxed apples size by weight while practically all machines used for barrel packing size the fruit by measurement. Some growers have obtained the machines used in the Northwest and have employed them to size barreled stock, but they have not proved as satisfactory as the machines which are especially designed for this purpose. They are constructed to size the fruit more accurately than is necessary for barrel packing and for this reason the capacity is very much less than that of the machines which size by measurement.

At present sizing machines are being used to a greater or less extent for barrel packing in all sections to meet the demand for apples that are uniform in size. The commonest practice throughout the barreled apple sections is to separate the fruit into two standard sizes 2¼ inches to 2½ inches and 2½ inches and larger. Such sizing is customary whether the grading is done with machinery or not, but it can be done more rapidly and accurately by the mechanical sizer. The use of the machine enables the grower to give more attention to the grading of the fruit, as the sorters are not concerned with the size classification. Where greater uniformity is desirable the machines are equipped to sort the fruit into variations of one-fourth inch, and where this is done the mechanical sizer is of even greater value, as a uniform pack may be secured with inexperienced help.

The sizing machines used most extensively for barrel packing are essentially simple in construction. They consist of two parts—canvas conveying-belts on which the fruit is sorted, and the sizing device proper. The fruit is delivered to the grading belt as it comes from the orchard and is sorted as it moves toward the sizer.

One of the most popular types is equipped with endless chain belts about 2 feet wide, composed of rings of a certain size. (See fig. 6.) Two to four of these belts are uesd and are arranged in series so that the fruit progresses from the smallest to the largest rings. As the apples are delivered onto these chain belts from the grading belt they either drop through the rings of the first or are carried on to the next. Where two chain belts are used the fruit too small for packing drops through the first, which is usually composed of 2¼-inch rings. The rest of the fruit is carried to the second chain composed of 2½-inch rings through which all the apples between 2¼ and 2½ inches drop. Those remaining are carried by a short conveying belt to a packing bin equipped with an apron. This size includes all apples 2½ inches or more in diameter.

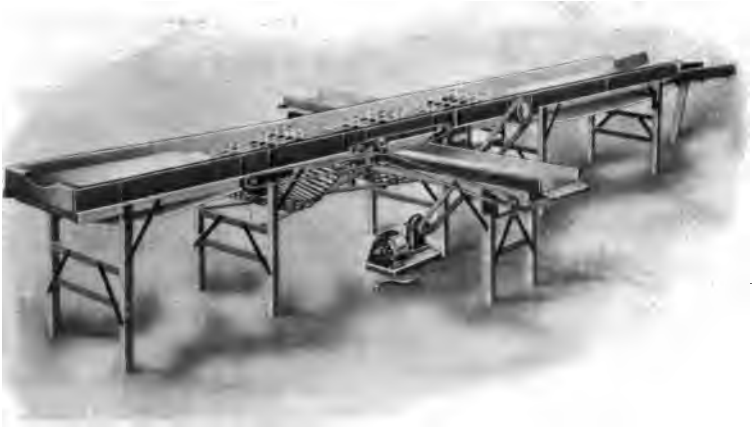

FIG. 6.—Machine equipped with sizing belts made of linked rings.

The sizing chains are inclined or otherwise arranged so that the position of the fruit is changed several times as it is carried over the rings. This is necessary to secure the measurement of the transverse diameter, which is the dimension used as the basis for all sizing. Apples occasionally fall onto the sizing rings so that they are measured by the longitudinal diameter, which causes large and small apples to appear in the same bin. It is necessary to measure each apple by the same diameter to secure uniformity.

Another popular device for sizing consists of rollers or belts spaced close at one end and diverging toward the far end. The fruit progresses along these rollers or belts until a place is reached which is wide enough to allow it to fall through. Several machines employ this principle to great advantage. The most common one is equipped with an endless horizontal belt which is inclined in such a way that the fruit rolls toward the lower edge where it comes in contact with a revolving roller. (See fig. 7.) This roller is set at a height of 2¼ inches above the belt at one end and 3 inches above at the opposite end. This arrangement would provide for three sizes, 2¼ to 2½ inches, 2½ to 3 inches, and 3 inches and larger, the largest size being carried over the end of the belt. However, the roller is adjustable and may be set at various heights, depending upon the number of sizes desired.

Another machine, which employs this principle but in which a board is substituted for the revolving roller, may be constructed by the ingenious grower at a very slight expense. This machine is easily operated, inexpensive, simple in construction, does not bruise the fruit, and the speed is sufficient for an output of 100 to 150 barrels a day. In feeding the fruit to the machine care must be taken that all of the apples come in contact with the board so that they will be sized correctly. If too many are fed at one time, all will not touch the board.

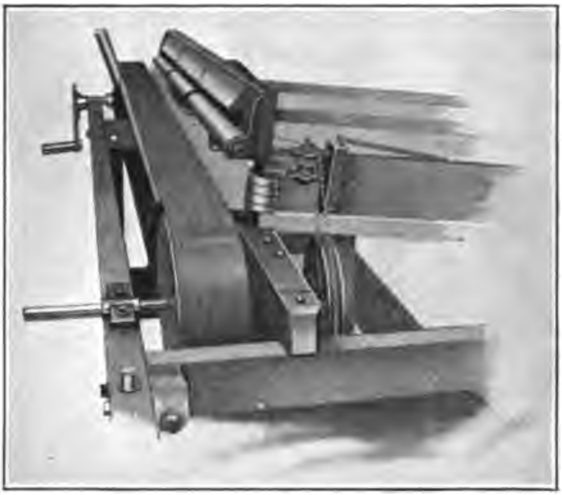

FIG. 7.—With this type of machine the fruit is sized in the slot between the roller and the horizontal belt.

Another similar arrangement consists of two spiral or corkscrew-like rollers which are set horizontally and which diverge in the same way as the machines which have been described. (See fig. 8.) The fruit is carried along the slot between the two rollers, which revolve away from each other. When a point is reached where the space between the rollers is wider than the diameter of the fruit the apples drop into the bin below.

In another type of machine the fruit is dropped into a series of cups or pockets, operated as an endless belt. (See fig. 9.) These cups or pockets enlarge as the fruit is carried along until the diameter is great enough to allow the apple to drop through into the bin.

The machines which have been described are usually operated by gas engines or electric motors, but practically all manufacturers put out small hand-power machines light enough to be moved about from place to place in the orchard.

In general, any of these machines will size apples satisfactorily for barrel packing. The choice of the machine will have to be made by the grower, based upon a consideration of the size of the orchard, the equipment already on hand, the accuracy required, and number of sizes desired. There are a number of points that growers should keep in mind in making this choice; (1) The machine must have a capacity proportionate to the size of the orchard so that the operation can be conducted economically. In choosing between two machines, one which has a large capacity but is only moderately accurate and the other which has a small capacity but is very accurate, such as those used in connection with box packing, the former is preferable in most cases. (2) Simplicity of design and freedom from too numerous adjustments are features very much to be desired. The machines that size most accurately are generally expensive, cumbersome, and fitted with numerous delicate adjustments which tend to make them undesirable for barreling operations, as barreled apples are usually sized in one-fourth inch variations and extreme accuracy is unnecessary for this purpose. (3) An investigation should be made to see that there are no arrangements or devices that will unduly bruise the fruit. If the apples are bounced along on metal or un-

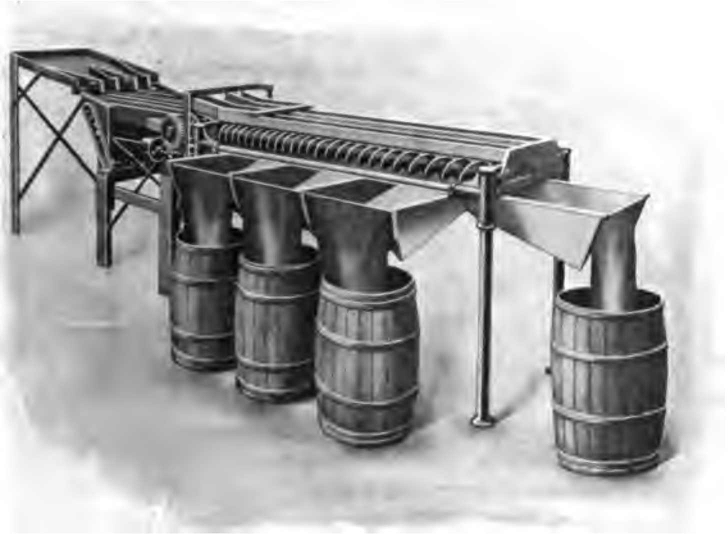

FIG. 8.—Sizing machine with diverging spiral rollers.

padded parts, or if the construction in any way necessitates crowding or congestion, there is danger of injury, and such a machine will not be suited to tender varieties. (4) The durability of the machine is a matter of great importance. If such a machine is not substantial, it will soon go to pieces when subjected to the rough handling that is usually given such equipment.

ADDITIONAL EQUIPMENT FOR SIZING MACHINES.

Practically all sizing machines in use at present separate fruit of one grade into various sizes, but by dividing the grading belt lengthwise with a strip or pipe and rearranging the chutes which divert the fruit from the sizing device to the packing bins, two grades may be sized at the same time. Assuming for the purpose of illustration that A and B grades are to be sized separately, the grading operation is carried on in the following manner: The field-run fruit is emptied on the belt and passes on both sides of the partition. The culls are first removed into containers provided for that purpose, then the sorters standing on the "A" side do not handle the "A" grade fruit but put the "B" grade across the partition, and the sorters on the "B" side permit the "B" grade fruit to pass, and put the "A" grade across. With this plan only 50 per cent of the fruit is handled, no matter what percentage of the crop falls in each grade, except such handling as may be necessary to determine the grade.

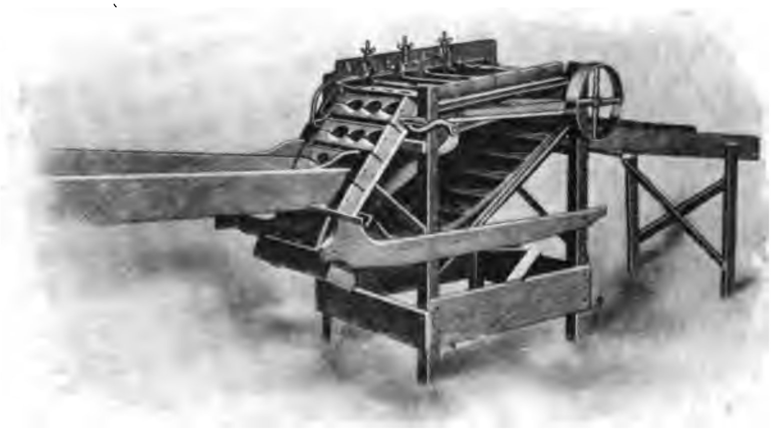

FIG. 9.—This machine sizes the fruit through cups which enlarge as the belt moves along.

Perhaps a better way of dividing the fruit is to divert all the fruit to one side of the partition. Where this is done, the grade constituting the smaller part of the crop is sorted out and placed on the opposite side of the partition. This requires the handling of a smaller percentage of the fruit than the other method, unless the crop is evenly divided between the two grades.

In most commercial operations the second grade fruit is not separated into various sizes, but all of it above a certain minimum diameter, usually 2¼ inches, is packed together. Instead of following the usual practice of sorting out this grade into baskets or barrels, a canvas conveyor 5 or 6 inches wide, placed about 18 inches above the table, may be used to advantage in carrying the fruit to a side bin at the end of the machine.

The efficient disposal of culls is a point which is very commonly neglected and often an accumulation of this fruit on the packing floor is allowed to interfere with the other operations of the crew. In many houses the culls may be conveniently carried to the basement by canvas chutes. Where this is done, they must be removed later by elevators or the house may be so constructed that it is possible to drive directly into the basement. Where there is no basement, conveying belts may be used to carry the culls to elevated bins, from which they can be removed through a trap into wagons.

The method of feeding the fruit to the sizing machine is another point to be studied carefully, as it influences directly the total daily output and consequently the cost of operation. In the first place, it should be possible to supply a continuous flow of fruit to the sizer without any tendency toward crowding or bruising, and, second, it should not be necessary to lift the filled containers to any considerable height from the floor in order to empty them, especially where the loose fruit is hauled in barrels. Unnecessary lifting may be avoided by elevating the receiving platform or floor about 30 inches above the main packing floor, or to a little less than the height of the sizing machine, thus permitting the emptying of the fruit at about floor level. With this feature of construction, the feeding can be still further facilitated by installing a belt 10 to 15 feet in length to receive the fruit. This belt ordinarily should extend along the receiving platform at right angles to the grading belt, thus making it possible to empty the loose fruit at any point along the line Extended observations indicate this to be the ideal arrangement.

Another method of feeding consists of pouring the fruit into a hopper on the floor level, from which it is carried to the sorting belt or sizer by means of an elevator belt. This method is in rather common use in sections where the loose fruit is hauled in barrels, and in some houses has given satisfactory results; however, without careful management, there is a marked tendency to bruise the fruit. In the first place, the man emptying the barrels may allow them to rest partially upon the fruit in the hopper; then when the hopper is full, the elevating belt frequently carries several apples half way up the incline between the lugs and this fruit is generally bruised by rolling back into the hopper. The hopper method is also somewhat slower than the belt running on the level of the machine, as it is obvious that a feed belt carrying fruit on lugs placed several inches apart can not have as great a capacity as one running on the level. If a hopper is used it must be properly padded.

POWER.

Only the small machines can be operated by hand power. Some of the simple types, having a capacity of around 100 barrels a day, can be run in this way, but in nearly all cases the use of a gasoline engine or an electric motor is preferable. It is generally best to place the engine or motor in the loft or basement or under a shelter outside of the building in order to leave the packing house floor clear for the operation of the crew.

The speed of the machine needs to be regulated very carefully, as the accuracy and care with which the apples are handled are largely dependent upon the speed of the belts and chains. Practically all machines when run too rapidly are inaccurate and cause an excessive amount of bruising. When the conveyor belt delivers the fruit very rapidly to the sizer a congestion may result from the inability of the sizing device to size all of the apples delivered on it. When it is desirable to increase the output of the machine the fruit should be supplied in an uninterrupted flow rather than by increasing beyond normal the number of revolutions of the drivewheel.

CONVEYORS.

Two types of mechanical conveyors are used extensively in packing house operations—the endless chain or belt operated by machinery for conveying loose fruit or light packages, and the roller type for conveying filled packages by gravity. Chutes may also be used to advantage to convey fruit (especially culls), or packages to a basement or lower floor. The belts are made of heavy canvas or rubber fabric, and vary in width as desired. A smooth board is supplied as a floor over which the loaded part of the belt travels so that it will not sag or fold under the weight of the fruit. Canvas belts or chains fitted with lugs, and supported by a trough are used where the fruit is elevated or lowered.

The roller conveyors provide a convenient means of moving fruit in packages either packed or unpacked from place to place on the packing floor. This type of conveyor is especially useful in connection with the unloading of containers of fruit from the orchard. They are delivered to the end of the conveyor from the wagon and are carried quickly to any part of the house desired. Where the fruit is to be carried from one point to another within the house, this operation may be performed more rapidly and with less labor expense by the use of gravity conveyors. In most cases two men can do the work of four without such equipment.

GRADING LAWS.

The enactment of grading laws for apples is a development of comparatively recent years. The first definite attempt toward securing the passage of such legislation was initiated in 1907 by a number of prominent growers, shippers, and dealers, who, after a protracted struggle lasting for several years, finally secured the passage of the present Federal law, commonly known as the Sulzer bill. This law served the valuable purpose of awakening and crystallizing public sentiment throughout the country favoring legislation which would stabilize the barreled apple industry by eliminating fraudulent and deceptive packing, and by establishing a uniform basis for buying and selling. In 1911, when the Sulzer bill was pending, a law based upon its provisions was passed by New York State. In August, 1912, the Sulzer law was signed by the President to take effect July 1, 1913. In 1913 the State of Maine passed a mandatory apple grading law. In 1914 New York passed a mandatory law which is still in effect in an amended form. This was followed by similar legislation in Massachusetts, Vermont, New Hampshire, Connecticut, Delaware, Kentucky, Maryland, Michigan, Pennsylvania, West Virginia, and Wisconsin. Apple grades have also been provided in Canada by the Canadian Inspection and Sale Act.

For several reasons the State laws have not been wholly successful in obtaining the desired results. In the first place the requirements of the laws have not been practical in all cases. Many of them were enacted hurriedly and most of them contained certain provisions which are not consistent with commercial practice, and, second, the extent to which these laws have been enforced in the different States has varied so greatly that in many instances the grade terms have come to have little or no value. Furthermore, the fruit from practically all of these States frequently appears in the same markets and the use of identical grade terms having different meanings in the different States has in a way defeated the purpose of the laws in that no grade term has ever stood for a standard pack. In spite of these objections, however, a State law that is practical in its specifications and intelligently enforced will carry with it many advantages. One of the most practical of the State laws has been enforced for a number of years and has given very favorable results. To be sure, there has been some dissatisfaction among certain growers during seasons when the fruit has been of generally poor quality, but conditions on the whole have been greatly improved. The law discourages deceptive packing, and, by so doing, materially increases the demand for fruit grown in that State.

PACKING.

THE BARREL.

The minimum capacity of the apple barrel has been fixed by an act of Congress at 7,056 cubic inches, or somewhat over 3 bushels, and the "short" barrel is a thing of the past. Half and third barrels are permitted by this law, but they are used by growers only in rare instances where a fancy grade of fruit is shipped direct to the consumer. In certain parts of New England flour barrels, which are slightly larger than the United States standard barrel, are used to a certain extent.

Several kinds of wood are used in the manufacture of barrels, the principal ones being oak, pine, poplar, and birch. Barrels are usually coopered with six hoops, but in certain localities growers bind their barrels with eight hoops, using four instead of two quarter hoops. This practice insures greater strength, as the single quarter-hoops are often broken in handling and a barrel without quarter-hoops is very likely to be badly sprung. Barrels fitted with double quarter-hoops are stacked more solidly on the bilge as they are prevented to a certain extent from rocking. In certain parts of New England iron hoops have been adopted and are quite generally favored. They are forced into place and will hold securely without nailing in practically all cases, but the safest procedure is to secure the top hoops with two or three nails and avoid the possibility of their working loose. Wire quarter-hoops are commonly employed by some eastern growers, who claim that they fit more tightly and do not break as easily as do the wooden hoops. However, if wire hoops are broken or become untwisted at the joint, it is almost impossible to repair them without special equipment.

Two grades of barrels are made; the chief difference between them lies in the kind of wood used and the workmanship. The No. 1's are made from the better woods and more care is exercised in the selection of the hoops than in No. 2 stock. The heads of the No. 1's are usually made from two or three pieces while those of the No. 2's are frequently composed of four pieces. Barrels of the first grade are probably more economical on the whole, as those of the second grade frequently break and cause extensive loss in handling.

The barrel is generally delivered to the grower with both heads and all of the hoops in place, but with none secured by nails. This permits storing it indefinitely without danger of warping. Upon removing the barrel from storage one head is then nailed in and liners, which are thin gum strips, are tacked over the ends of the pieces making up the head to prevent them from breaking out of the croze ring. The quarter hoops are secured by two nails on each side of the barrel. The other head is then removed and placed in the bottom of the barrel.

FACING.

The first step in packing a barrel is that of facing, or arranging the first and perhaps the second layer of apples in concentric rings on the bottom of the barrel. (See fig. 10.) Practically all growers use the single face, consisting of one layer, but the double face is used occasionally, especially for fancy fruit. The fruit is packed stem down except in the case of the second layer of the double face, which is often packed on the cheek. When the barrels are single faced they are backed up with a layer of "spotters," or apples dropped into the spaces between the apples of the face, so that the red cheeks face downward and show through to the best advantage when the barrel is opened. The "spotters" also keep the apples of the face in place when the remainder of the stock is poured into the barrel. The double face has no advantage over the single face and only tends to create a false impression of the rest of the contents.

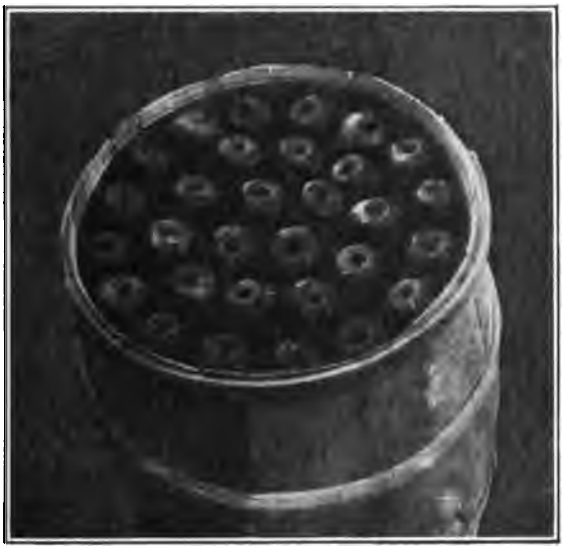

FIG. 10.—An excellent face made with 2⅜-inch apples.

The advantages of the single face are three fold. First, it legitimately increases the attractiveness of the pack and draws the attention of the prospective buyers more readily than if there were no order of arrangement. Second, by carefully placing the first two layers in the bottom of the barrel, a large amount of bruising is avoided that might occur if the apples were dropped into place carelessly. Third, by placing the apples evenly over the surface of the head and then reinforcing them by spotters each one shares an equal amount of the pressure of the head and the amount of bruising is thus reduced to a minimum.

The chief objection to the practice of facing is that as a general rule only those apples of superior size and quality are considered desirable for this purpose. Unreliable packers have resorted to the practice of facing with fruit far above the average quality of the barrel in order to deceive and defraud the buyer. There has been so much dissatisfaction and loss as a result of this method that a strong sentiment has developed among the growers and dealers in favor of enacting legislation requiring the face to represent fairly the average content of the barrel. Owing to the fact that the trade expects and customarily demands an attractive pack, the better-colored apples of uniform size may be placed in the face, but the general quality and size should conform to the grade of the remainder of the barrel.

FILLING THE BARREL.

After the barrel is faced, it is moved to the packing bin or grading table, where it is filled. Two methods of filling the barrel are used almost exclusively because they make it possible to lower the fruit into the barrel with a minimum amount of bruising. Filling is usually accomplished by the aid of a canvas or burlap apron attached to the grading table or packing bin, but it may be done equally well by the use of half-bushel baskets which are lowered into the barrel and emptied.

Where the slatted inclined table is used, or where a sizing machine sorts the fruit into packing bins, the apron attachment is employed, but where the fruit is emptied from field crates onto canvas-topped tables and is hand-sorted into half-bushel baskets, it is emptied directly from these baskets into the barrel. Either method is satisfactory if the packers employ a reasonable amount of care.

In addition to being carefully filled, a barrel must be packed tightly so that shrinkage and handling in transit or storage will not cause the pack to become slack. To insure a tight pack the apples must be settled thoroughly as they are placed in the barrel. This is done by racking.

"Racking" is a term used to describe the forced settling of the fruit by rocking a partially filled barrel back and forth in a sharp, jerky manner. (See fig. 11.) To produce a tight pack, the barrel must be racked after the first bushel is poured in upon the face and once again as each half bushel is added until properly filled for heading. The height of the fruit above the top of the barrel before heading varies ordinarily from one-half inch to 2 inches, depending largely upon the thoroughness of the "racking."

Under no circumstances should a grower omit "racking" and resort to overfilling as a means of making a tight pack, for no barrel which has been overfilled will pack as tightly as if is had been racked thoroughly to a height nearly level with the top. Pressing an overfilled barrel causes severe bruising all through the pack, but does not result in a thorough settling of the fruit. Though apparently tight when pressed, it will settle later and become slack. From all the evidence available it is apparent that one-half to three-quarters of an inch above the top of the barrel is a sufficient height for the contents of any properly packed barrel.

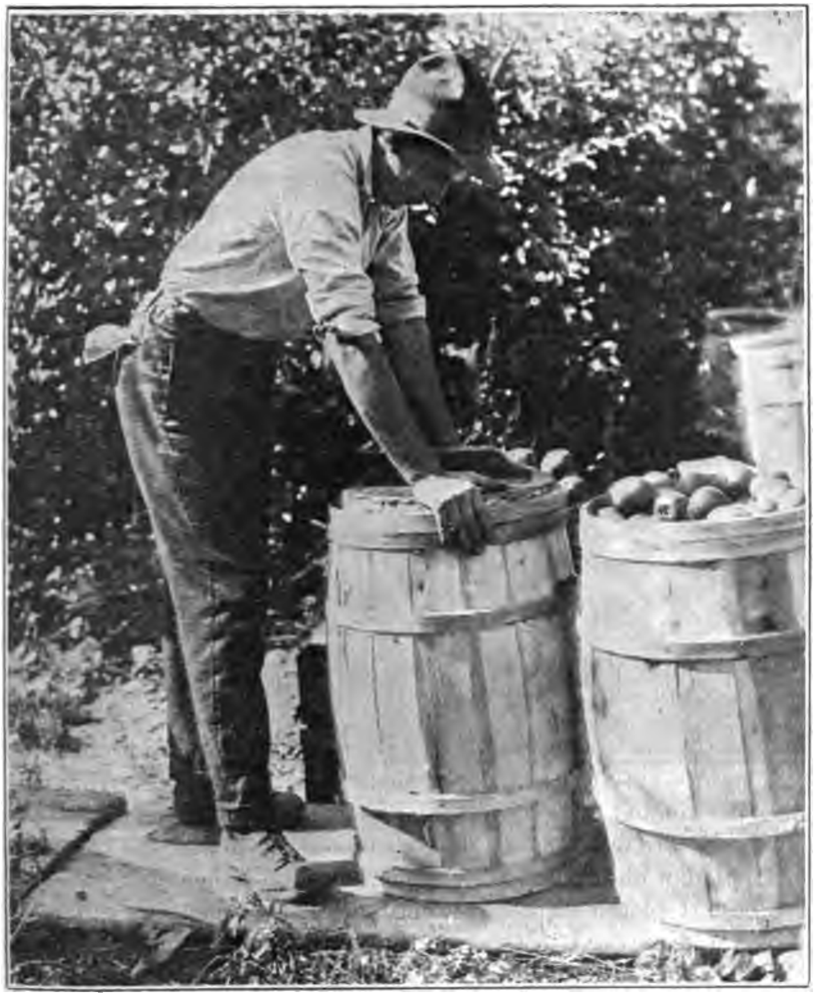

FIG. 11.—" Racking " the apples.

TAILING.

Before pressing the head into place it is important to level the apples on the "tail" so that the pressure will be distributed equally. This is accomplished in one of two ways, either by roughly leveling off the high places or by arranging all of the apples exposed into a plate formation similar to that of the face. The first practice, which is in most common use, is known as "jumble-tailing," and the latter practice is known as "ring-tailing." (See fig. 12.) The "ring-tail" is used to increase the attractiveness of the better grades. It also enables the grower to make a tight pack without injury from the pressure of the head. It is rather difficult for an inexperienced hand to arrange the "ring-tail" successfully, but a week's practice should enable the average person to put out 125 to 150 barrels a day.

The process of "tailing" is greatly facilitated by the use of the "follower" or "shaker," which is a heavy circular piece of wood made from 2-inch planks with a handle on top and thickly padded on the underside. It is fitted into the head of the loosely filled barrel, and being held in place during the racking operation it causes the fruit to settle with an even surface. The "follower" is applied to the full barrel if the "jumble" tail is used, but if the pack is "ring-tailed" it is applied before the barrel is quite full, so that the last layer of apples will bring the contents to the desired height before heading. The follower is universally used and favored, as it amplifies both methods of tailing.

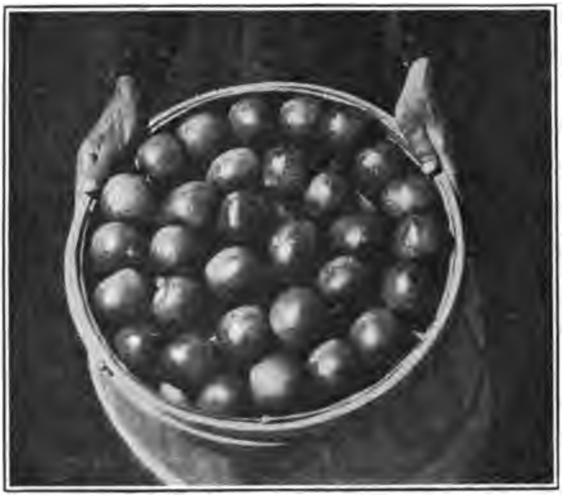

FIG. 12.—A good example of "ring-tailing."

PADS.

Corrugated pads are used by practically all growers to reduce the amount of bruising caused by pressing the head into place. If two pads are used, one is placed under the face and the other over the tail; if but one is used, it may be placed on either end, but it will serve best if placed on the tail end, especially when the apples are jumbled and exposed to the rough and frequently uneven pieces of the head which cut and bruise the fruit when the pressure is applied. Excelsior cushions are seldom used because they are more expensive and have no particular advantage over the corrugated pads in ordinary packing operations. If, however, a delicate and easily bruised variety is being packed for show purposes such pads may be used to advantage.

BARREL PRESSES.

The type of press used to head the barrel is a matter of considerable importance since there are two principles of construction involved, one of which is outstandingly superior to the other. The pressure in one case is applied by means of a screw and in the other by means of a lever.

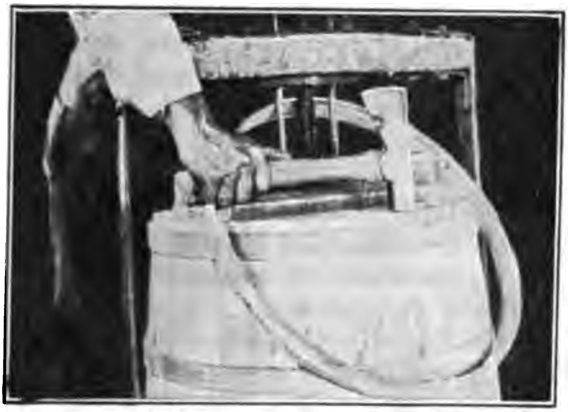

FIG. 13.—The screw press used for heading barrels.

The screw press, shown in figure 13, although probably slower in operation than the lever press, is favored by a large majority of the apple growers, as it enables the packer to head the barrel with a minimum of bruising. This is possible because the pressure is exerted as a steady force which adjusts the head by degrees, and the severe shock that usually accompanies the use of the lever is avoided. Where the lever type of press is used it is not at all uncommon to see the header jump on the lever and bring the head into place with a crash, this causing severe bruises and skin breaks.

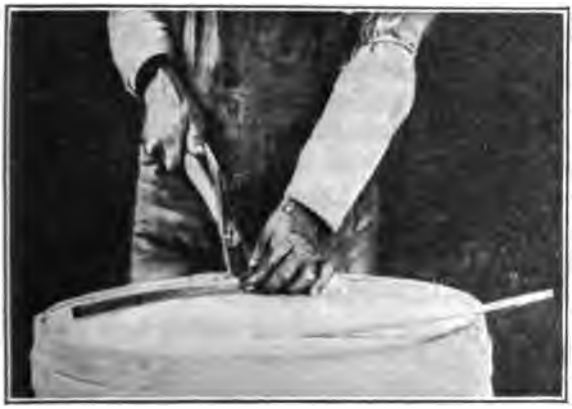

FIG. 14.—Nailing on the head liners.

An attachment to the screw press which has been recently introduced and which is being adopted rapidly consists of a platform on which the barrel rests when it is headed. When not equipped with such a platform, the press hooks onto the bottom of the barrel by means of iron strips that extend down each side. This arrangement is open to the serious objection that it is likely to break the bottom hoops as the head is pulled into place, especially if the barrels are old or damp, thus materially weakening the barrel for subsequent handling.

NAILING.

When the head has been pressed into place, and the upper hoops have been tightened, the barrel is ready to be nailed. The nails should be driven through the top hoops at an angle of about 45°. Nails driven horizontally into the ends of the pieces making up the head frequently split the wood and do not hold as securely as when driven at an angle. From six to eight nails will hold the three and four piece heads in place and the use of more is a waste, especially when as many as 12 to 15 are used. If barrels are to be handled roughly or are to be transported long distances they should be additionally strengthened by the use of "liners" nailed over the ends of the head pieces. (See fig. 14.) The use of liners tends to prevent the head from springing out of the croze when the pack is submitted to a severe strain.

PACKING HOUSES.

Many types of structures are used for apple-packing operations, ranging from tents and sheds to permanent buildings equipped with packing machinery. The most desirable type depends largely upon the size of the orchard and the section of the country in which it is located. In many places where the individual orchards are too small to justify the erection of modern packing establishments, such houses have been built and operated successfully as community enterprises. Such a plan has a much better chance of success if the roads in the district are good and the orchards are not too widely scattered. The community house enables the small grower to profit by the division of labor and the increased efficiency of labor-saving machinery, and the standardization of pack is also of marked advantage in disposing of the crop.

Packing houses can be discussed best on the basis of their equipment. Those having no labor-saving machinery other than the ordinary implements used to fill and head the barrel are in one class, while those equipped with sizing machines, gravity and belt conveyors, and various other mechanical devices constitute another class, regardless of the amount of floor space or the construction of the building in either case. Very often a large tent or shed will be filled with apron tables all operated independently of each other so that there will be no division of labor among the hands employed. Such a house can not reasonably be classed with one that is prepared to increase the number of barrels packed per man no matter how much greater is its total output.

The equipment of a house operating without machinery differs little from the usual field layout, and for that reason the following discussion is concerned primarily with the establishment of a modern packing house fitted with labor-saving devices designed to facilitate the various operations and to reduce the packing costs.

LOCATION.

In choosing the site for a packing house there are a few points which if kept in mind should enable anyone to select the proper location without difficulty. A community house, practically without exception, should be located on a railroad to avoid the added expense of hauling the loose fruit to the packing house and the packed fruit to the railroad. This is particularly true where the packing house is built in connection with the storage house. Individual houses may also be located to advantage on the railroad if the roads from the orchard are good, but if they are not, there is too much difficulty in moving the unpacked fruit without injury.

If located at the orchard, the position of the packing house will depend largely on the lay of the land. If the land is level, it is sometimes an advantage to have the house in the middle of the orchard, thus reducing to a minimum the aggregate distance for hauling the unpacked fruit. When the road to the shipping station is good and will permit the hauling of heavier loads than can be pulled through the orchard the house should be placed on this road, and in a hilly orchard the house should be located where there is a minimum amount of uphill hauling.

Where it is desirable to have a basement storage, advantage may sometimes be taken of a slope to build a house with the receiving platform level with the wagon beds on the upper side and the floor of the basement level with the wagon road on the lower side. With this arrangement the fruit can be conveyed to the basement by gravity and removed without the expense of operating elevators.

LIGHTING.

In the construction of a house or in the remodeling of an outbuilding for use as a packing plant provision for an abundance of light is of first importance, for the thoroughness of the work is severely impaired where the fruit is partially in shadow. Light may be admitted into the packing house in several ways. Skylights and windows high up on the walls in sufficient number to light the interior thoroughly offer the most satisfactory lighting arrangement. Where the house is constructed with a loft the skylights can not be used, and the light must be admitted from the sides of the building, either through sliding doors and windows or through hinged doors that swing upward and outward. A large house that depends upon side illumination is likely to have a dark region toward the center, even though the sides may be entirely open, but if all tables and conveyor belts used for sorting are placed along the sides of the house the light will fall directly on them. Light shafts are used to increase the amount of natural illumination and white paint is applied to interiors to intensify and reflect whatever light is available. If artificial illumination is used, special care should be taken to have the lights for the sorting operations arranged so that there will be no shadows on the fruit. For this purpose reflectors in the shape of an inverted trough fitted with electric bulbs can be suspended over the grading belts or tables.

STORAGE ACCOMMODATIONS.

Every packing house should have adequate space for the storage of empty barrels and for the temporary storage of loose fruit from the orchard and packed fruit intended for storage or shipment.

If 50 per cent or more of the barrels needed for the crop can be stored in the house at one time there is little danger that the necessary supply will be lacking during the height of the season and the operations suspended, which frequently happens when the barrels are secured from day to day from a local cooperage. With this in mind, some of the growers in the East who pack out the largest crops use a barn or attached building for a barrel storage and lay in a large reserve supply.

A loft or second story immediately over the packing floor constitutes the most satisfactory barrel storage. If barrels are stored on the packing floor, the house must be unusually large to accommodate them or congestion and confusion will result. Where the floor is only large enough to accommodate the packing operations the storage of empty barrels, except the necessary working surplus, takes up space which can be used to better advantage for the accumulation of loose and packed fruit.

The floor space adjacent to the feeding belt should be devoted to the storage of enough field-run fruit to supply the crew for several hours or longer so that temporary interruptions in the delivery of fruit from the orchard will not affect the continuity of the packing operations.

It is also well to provide additional room for at least one day's output of packed fruit awaiting movement. A shortage of cars or of hauling facilities frequently prevents the removal of the fruit as rapidly as it is packed and space should be provided to accommodate such fruit temporarily without hindering the packing operations. This space may be provided on a covered platform which furnishes protection from the rain and sun.

VENTILATION.

Another important consideration is adequate ventilation throughout all parts of the house, especially those parts intended for the storage of fruit. Where the storage room for ungraded fruit, culls, or packed fruit is inclosed, abundant ventilation is needed. The main packing room will seldom lack this feature, owing to the number of windows required for proper lighting.

SUGGESTED FLOOR PLANS.

It is impossible to give here the exact specifications for building packing houses, but with the aid of several suggested floor plans certain desirable features of construction and arrangement for the convenient and economical handling of the fruit may be pointed out.

The type of house suggested in Plan 1 is designed for handwork operations where the ordinary apron or canvas top tables are used. (See fig. 15.)

The dimensions of this house are 30 feet by 60 feet, which, with a double apron table, should provide for an output of 200 barrels per day. For larger operations the floor space and number of units may be increased indefinitely. As will be seen, the house is divided into two sections, one to be inclosed for an empty barrel storage and the other to be left open on two sides for the packing room. The space available for the packing operations is increased by the addition of two covered platforms 5 feet wide extending along the open sides of the packing room. The driveways should be built so that the wagon beds will be on the level with these platforms in order to facilitate loading and unloading. The fruit is received on one platform and passes in an orderly manner through the packing operations to the other side of the house, where it is loaded on the wagons. The arrangement of the equipment is such that the work can be done without any unnecessary moving around or waste motion. The extra space in the packing room is provided for unpacked and packed fruit.

Plan 2 shows a house equipped with three grading machines which have a total capacity of approximately 1,200 barrels a day. (See fig. 16.) A house having a very similar plan is operated at Biglerville, Pa. This arrangement is particularly well adapted to a community house where fruit is being packed for a number of growers. The feeding belts marked *A* are a very desirable feature, as fruit may be emptied on the machine from practically any point along the receiving platform. The fruit passes over the sizing chain *B*, where the fruit smaller than the minimum size for packing is dropped into a cull chute *C* leading to the basement. The remainder of the fruit is then delivered to the grading belt *D*, where the culls are removed by the sorters and dropped into another branch of the cull chute. The grading belt may be divided as illustrated in the middle machine shown in this plan so that two grades may be sized simultaneously. In this case the sorters who work on both sides of the grading belt divide the fruit into two grades, which are placed on opposite sides of the division board *E*. The first size, which usually consists of all fruit from 2¼ inches to 2½ inches in size, passes through the rings marked *F* into the bins *G* and *GG*. But the fruit 2½ inches in diameter and larger is carried up the elevator belt *H* onto another belt *I*, which delivers the B fruit into bin *J* and the A fruit into the double bin *K*. This bin it fitted with a gate or deflector *L*, which when open fills the first compartment and when closed allows the second compartment to fill. Two bins are provided for this fruit because the

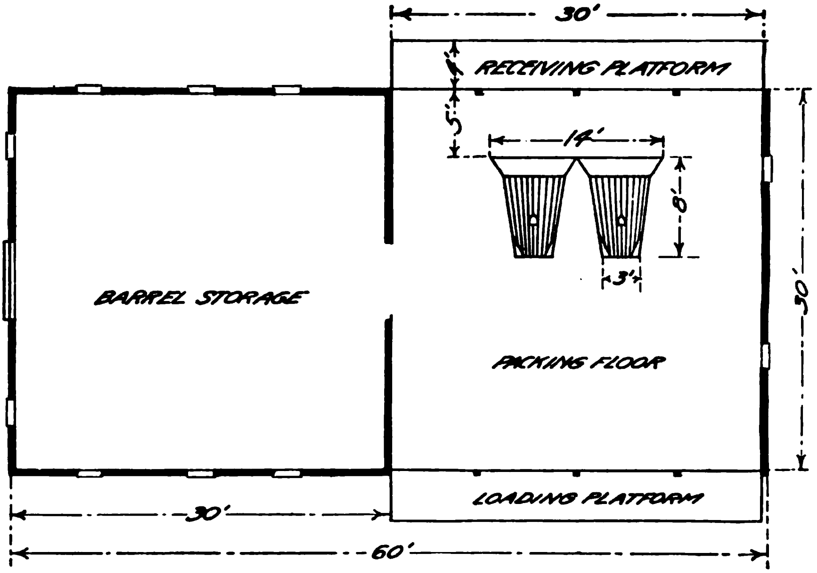

FIG. 15.—Plan 1: Floor plan of a packing house designed for handwork operations.

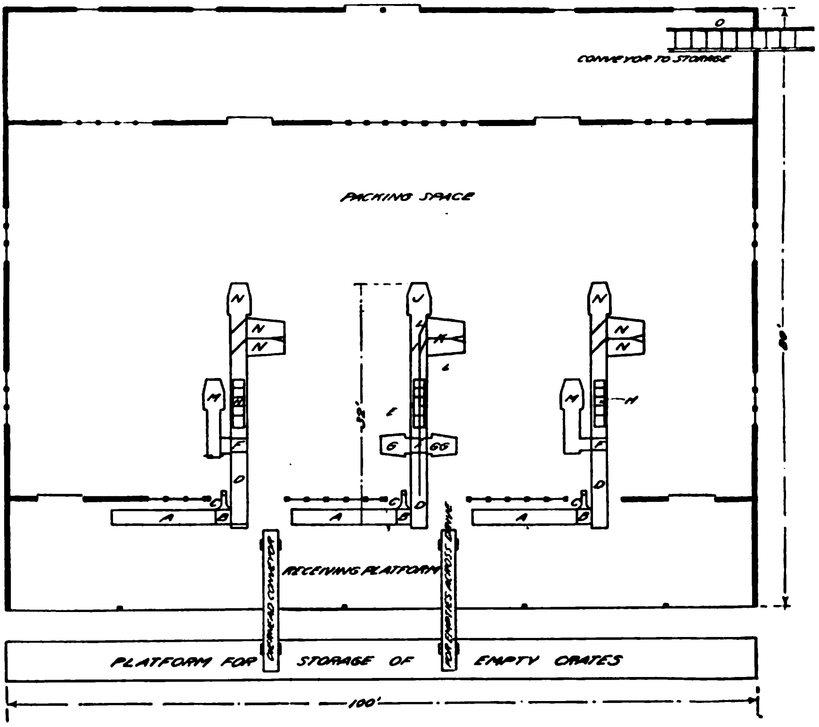

FIG. 16.—Plan 2: Floor plan for a community packing house with a capacity of 1,200 barrels a day.

bulk of the average crop runs A grade, 2½ inches and larger, and there must be bin space enough to accommodate all this grade when operating the machine continuously.

The end machines illustrated in this plan are not equipped to size two grades. Fruit of B quality is removed from the sorting belt into baskets and packed in the space behind the sorters, while the A fruit from 2¼ inches to 2½ inches passes through the sizing chains *F* and is conveyed into bins *M*. The bulk of the crop, which is A grade, 2½ inches and larger, is distributed among the three bins *N*. After the barrels are headed they are passed to the platform in the rear of the house, and from there may be transferred by means of the conveyor *O* to a storage or loaded on wagons and hauled to the cars. This house is equipped with two overhead conveyor belts for carrying empty crates across the drive from the main packing floor to the unloading platform. This arrangement keeps the whole area of the receiving platform available at all times for incoming fruit.

A loft should extend over the whole packing floor to serve as a barrel storage. The barrels may be coopered and stenciled here and lowered through shafts to convenient points on the packing floor. (See fig. 17.)

Plan 3 shows a house equipped with two machines having a total capacity of 1,000 barrels a day. (See fig. 18.) A house built and operated on this general plan was observed in Hancock, Md. The fruit is delivered on a receiving platform which extends the total length of the house. The fruit is emptied from the orchard containers onto the conveyor belts *A* at any point along the platform. These conveyor belts are elevated 8 inches above the receiving platform, which greatly facilitates the emptying of the crates. The receiving platform *B* is elevated 48 inches above the level of the packing floor. The sorters work on the platform *C*, which is elevated 18 inches. The machine has a total elevation of 56 inches, which makes it possible to deliver the fruit directly from the sizing chains into the packing bins by gravity. As the fruit passes over the first sizing rings at *D*, all the apples under the minimum size for packing drop into a chute which delivers them into a cull pile outside of the building. Sorters standing at the positions marked "X" remove the remaining culls and the B grade. The B grade is placed in baskets and emptied into bin *F*, which also contains the 2¼ to 2½ inch fruit. The remainder of the fruit is distributed to bins *G*, *H*, and *I*, which receive the sizes 2½ to 2¾ inches, 2¾ to 3 inches, and 3 inches and larger, respectively.

Apples of the various sizes which are selected for facing are carried to facing bins *J*. The full barrels are removed to the presses for heading. The barrel storage should be located in a loft over the packing floor, where the barrels are coopered, stenciled, and placed in racks *L*, from which they are removed by the persons doing the

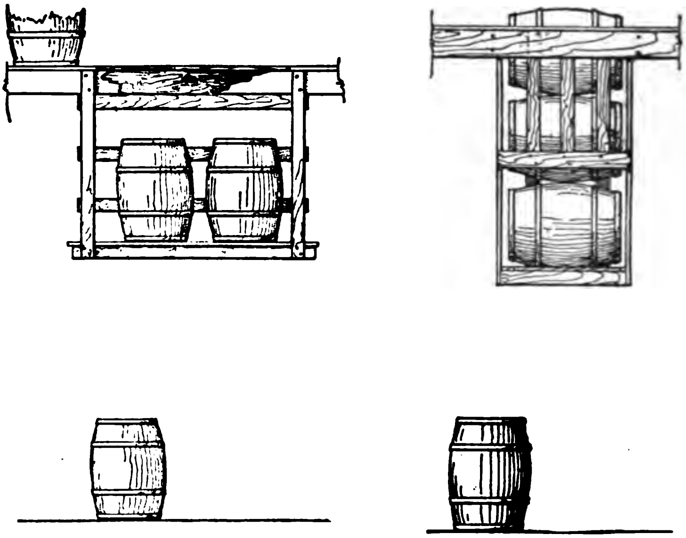

FIG. 17.—Two desirable methods of lowering empty barrels from the loft to the packing floor.

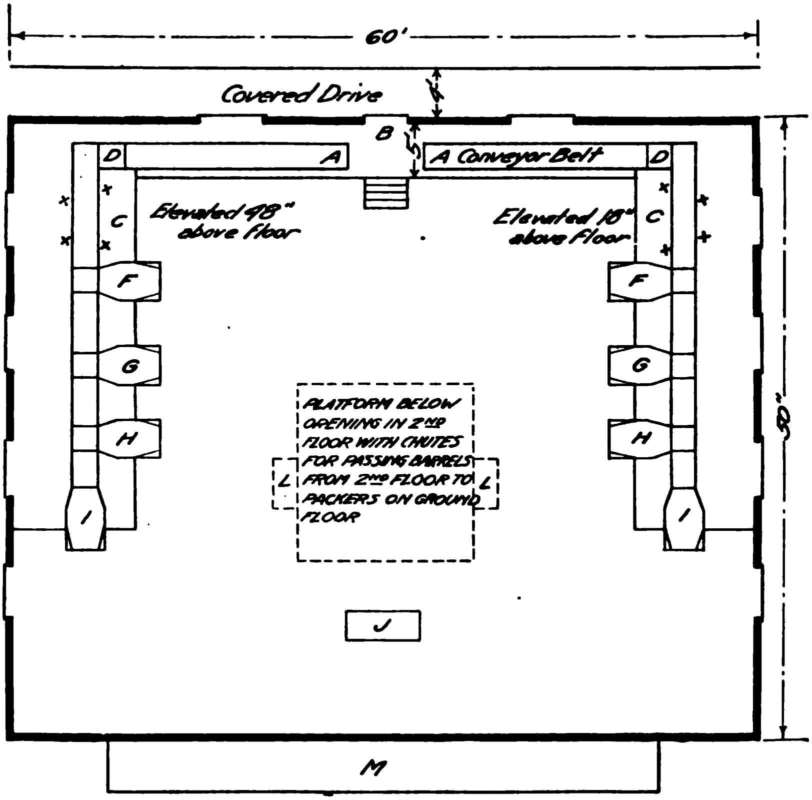
60'
Covered Drive
4'
B
5'
D
A
A Conveyor Belt
D
Elevated 18" above floor
Elevated 18" above Floor
C
C
F
F
G
G
H
H
I
I
PLATFORM BELOW OPENING IN 2ND FLOOR WITH CHUTES FOR PASSING BARRELS FROM 2ND FLOOR TO PACKERS ON GROUND FLOOR
L
L
J
50'
M

FIG. 18.—Plan 3: Floor plan for a well-arranged house capable of handling 1,000 barrels daily.

facing. Packed barrels awaiting shipment may be stored temporarily on the covered platform *M*.

In plan 4 an arrangement is suggested which embodies many of the features desired in a conveniently arranged packing house. (See fig. 19.) The overall dimensions of the house are 40 by 50 feet, with a total capacity of approximately 500 barrels per day. These dimensions, however, can be changed in case it is desirable to provide a larger space for the storage of unpacked and packed fruit. The actual floor space occupied by the packing machinery is 20 by 30 feet. A large loft over the packing floor is used for the storage of empty barrels. Barrels are also coopered in the loft and as they are needed are let down through the shafts *A*. This arrangement does away with an accumulation of empty barrels on the floor of the packing house, which would interfere with the operations of the crew.

The front of the house where the fruit is received is elevated 30 inches above the rest of the floor. The receiving space is enlarged by the addition of a 4-foot outside platform extending the width of the house. The feed belt *B*, which is 18 feet long and 2 feet wide, is raised 18 inches. The feed belt of an ordinary grading machine is approximately 3½ feet above the floor, and it is impracticable to empty barrels on a machine at this height. The fruit passes from the feed belt to the first sizing rings, where the cull fruit, smaller than 2¼ inches, is graded out. The fruit of a larger size passes to a grading belt *C*, which is 7 feet long and will accommodate six sorters. This belt is divided by a partition so that as the fruit passes along the B grade is sorted out and diverted into bin *D*. The culls are thrown into two chutes *E* leading to the bin outside the house. The A grade fruit passes to the next sizing rings, where the fruit 2¼ to 2½ inches in diameter is dropped into bin *F*. The remainder of the fruit is separated according to size into bins *G*, *H*, and *I*. Sorters stand on a raised platform 18 inches above the floor level. The machine is 48 inches above the floor and this height is sufficient to provide the proper drop to the packing bin. The fruit is loaded on the cars from a covered platform 6 feet wide and 80 feet long.

At the receiving end of the house there are three 10-foot doors hinged at the top to swing outward and upward. These doors when open form a cover to the platform and have the advantage of leaving the receiving floor free from obstruction. There are also 10-foot sliding doors at *J* on the side of the house and at *K* in the rear. Windows are provided on the sides of the house, and these, together with the doors, furnish an abundance of light for the packing operations.

Plan 4a illustrates the arrangement necessary for a house of the same capacity and construction as in plan 4, but equipped with a sizing machine of a different type. (See fig. 20.) The sizing mechanism is contracted into one unit, so that it is necessary to have the bins close together and distributed on both sides of the machine. Practically the only other differences between these two houses are the location of the shafts through which the barrels are introduced to the packing floor from the loft above and the arrangement for the removal of the culls, which in this case are delivered to a bin outside the house by chain conveyor *C*. The arrangement shown in the two plans 4 and 4a cover the range of requirements for all standard grading machinery now on the market.

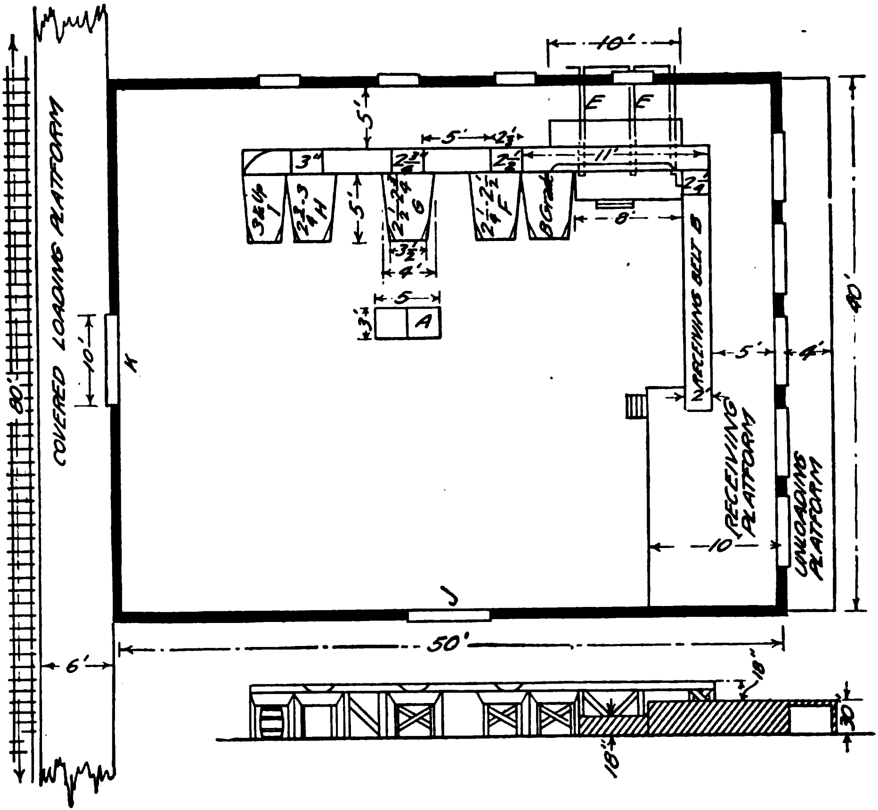

FIG. 19.—Plan 4: Floor plan of model house fully equipped for barrel packing.

HAULING.

As a large part of the barreled apple crop is packed at the orchard, it is usually necessary to haul the packed fruit from 2 to 15 miles to the shipping point, and it is important that this be done as rapidly and cheaply as possible and with a minimum amount of damage from shaking the pack and bruising the fruit.

Under many conditions, especially where good roads are available, motor trucks are best suited for such hauling on account of the combination of desirable features—speed, large capacity, and smooth carriage. Large trucks may be easily fitted with racks which make it possible to haul 35 to 40 barrels at a load. Tractors are also used to some extent for hauling two or more wagons hitched together. (See fig. 21.) The time gained in hauling the fruit by trucks or tractors is important in expediting the movement of the crop into proper storage and also reduces the amount of labor necessary.

However, the great bulk of the crop is hauled in wagons, owing to the fact that in most cases the individual orchardist can not afford to maintain for this purpose trucks which he could use to advantage only a very short period of the year. The farm wagon customarily used is equipped either with an ordinary wagon bed or a three-pole frame and has a capacity of about 15 barrels. (See fig. 22.) The box bed is less desirable than the three-pole frame, because the barrels must be hauled on end, which subjects the pack to a much more sever strain than when the barrels are loaded on the side. With the three-pole wagon frame the barrels are loaded on the side and the poles are springy enough to give a certain amount of buoyancy to the load. Both types of wagons should be equipped with springs,

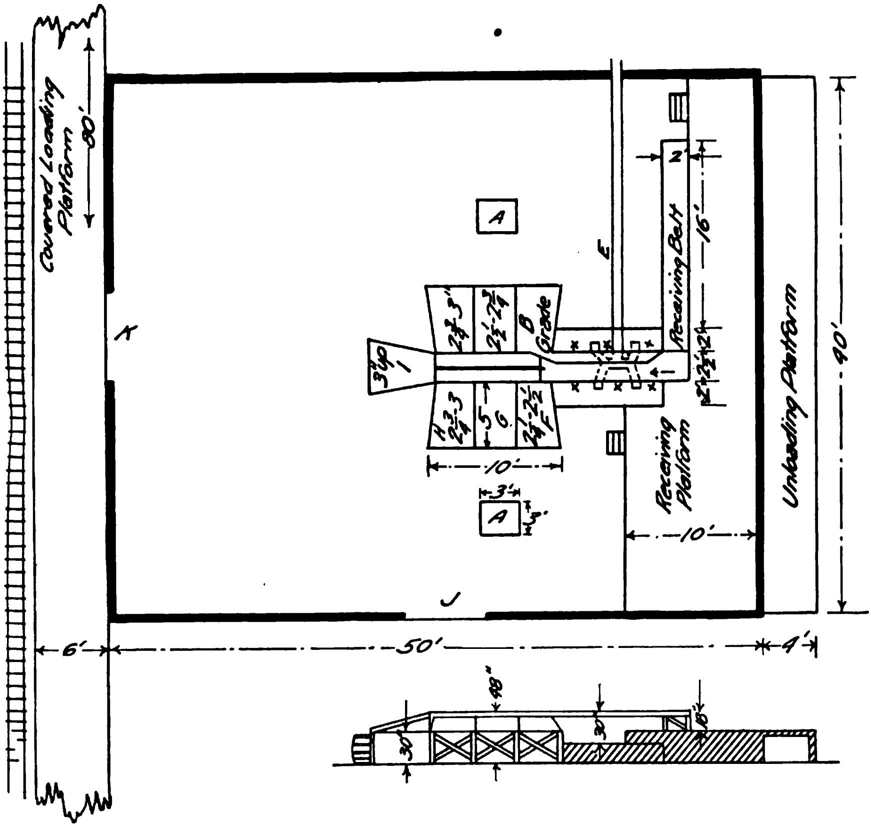

FIG. 20.—Plan 4a: Same as fig. 19, showing proper arrangement of a different type of sizing machine.

preferably with bolster springs which can be attached conveniently to any ordinary farm wagon. Indeed, the importance of springs can not be too strongly emphasized, for careful handling of the packed fruit is quite as important as care in any of the packing operations. A rough, jolting haul will frequently impair the rigidity of the package to such an extent that it will not withstand the strain to which it is subjected in transit.

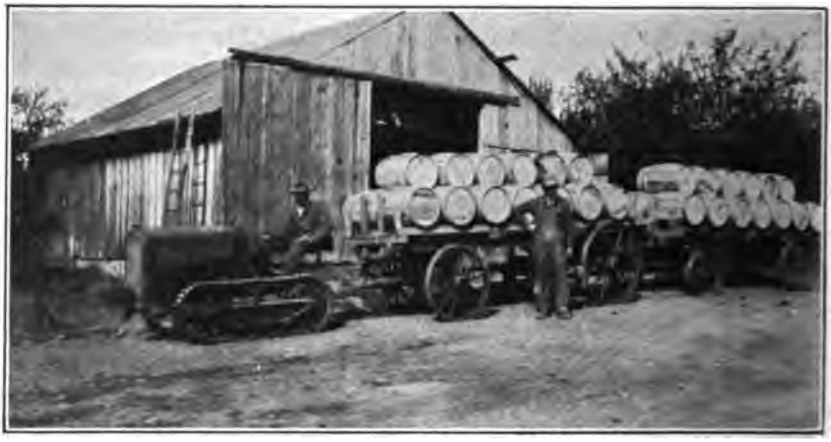

FIG. 21.—Small tractor hauling a load of 40 barrels.

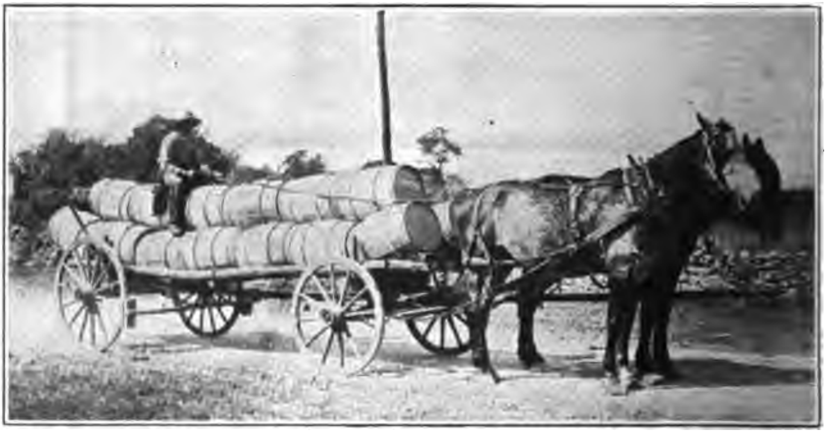

FIG. 22.—A three-pole wagon frame.

LOADING IN CARS.

A good system of loading must provide for the even distribution of the strain on the barrels, which must also be stacked tightly enough to avoid shifting and breaking. The barrels should be arranged in such a manner that adequate ventilation will be provided. The most popular and probably the most satisfactory method of loading is known as the alternating-straight load. (See fig. 23.) This load is

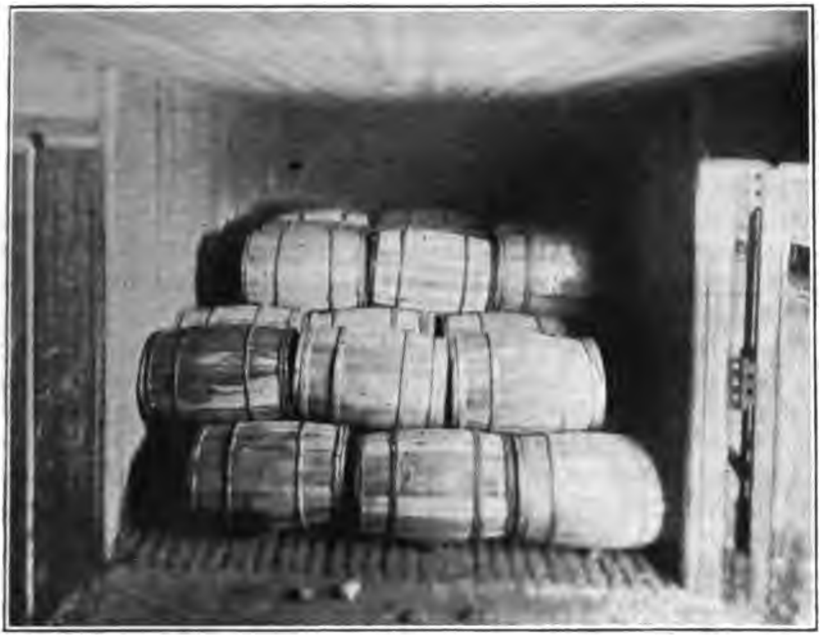

Fig. 23.—The "alternating-straight" method of loading.

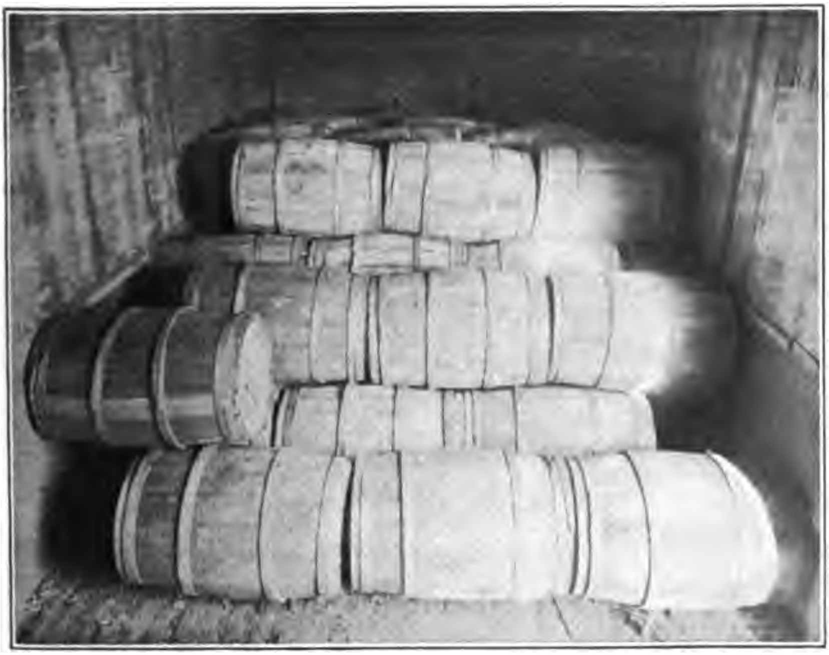

Fig. 24.—The "staggered" method of loading.

started by placing two rows of three barrels each, end to end, across the car which leaves a space of about half the length of a barrel at the end of the rows. The second layer is then started by placing a row of three barrels on top of the first two rows but starting from the opposite side of the car and covering the open space between the ends of the rows below and the side of the car.

The remainder of the car is loaded in the same way, alternate layers being started from opposite sides of the car. This forms long channels along the walls lengthwise of the car which serve as flues for the circulation of air. When cars are shipped under refrigeration a load stacked in this manner will cool down quickly, or if a ventilated car is used there is a free circulation of air throughout the car. An additional advantage is derived from this method because the bilge of one barrel does not rest directly upon the bilge of another, but rests in the hollow space over the ends of four barrels below.

Another method of loading almost as popular and differing but slightly from the alternating-straight system is known as the "staggered" load, so called because of the fact that the alternate rows of each layer rest again opposite sides of the car. (See fig. 24.) This load is compact and carries very well, but not any better than the first method. The arrangement, however, does not provide as good ventilation and there is the further disadvantage that part of the barrels rest directly on the bilges of barrels in the layer below.

A number of other methods of loading are used to some extent in different sections, but these are not as desirable, for various reasons, as the two which have been described.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1919

A1.9:1080

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Revise

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1080

PREPARATION OF BARRELED APPLES FOR MARKET

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INTEREST in commercial apple growing has been stimulated in the East and Middle West in a measure at least by comparative nearness to the large markets and correspondingly low freight costs, by the relatively low cost of orchard land, and by the prices obtained in recent years for properly graded fruit. This interest has found expression in the erection of modern packing houses, in the increased demand for labor-saving equipment, and in more careful grading and packing.

There is still great need for orchardists to study the various operations involved in moving the crop from the orchard to the market in order to reduce the cost of handling and to raise the general standard of the barreled apple industry. This bulletin provides growers with a basis for comparing their own methods with those employed successfully in representative orchards throughout the country.

Washington, D. C.

Issued September, 1919.
Revised August, 1925.

PREPARATION OF BARRELED APPLES FOR MARKET

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THE COMPETITION of an increasingly large tonnage of carefully graded boxed apples has resulted in a more exacting market and has emphasized the importance of the closest study of the details of operation and equipment in the marketing of barreled apples. Well-chosen equipment, up-to-date methods, and careful supervision of crews must supplant the haphazard methods which prevail to some extent in all producing sections.

HARVESTING

A large quantity of fruit reaching the market each season is greatly impaired in quality by being picked at the wrong stage of maturity, either too early or too late. This mistake is caused both by a misunderstanding on the part of many growers as to when the fruit should be picked, and by the failure to interpret correctly under field conditions the factors indicating the proper stage of maturity.

TIME OF PICKING

Varietal characteristics, seasonal variations, cultural practices, and other factors affect the maturity of apples, and it is difficult to lay down any fixed rules to determine the proper stage for harvesting. There are, however, certain indications of ripeness, such as red color, color of seeds, and ease with which the stems separate from the spurs. These will enable any grower with some practice to recognize the proper stage.

The amount of red color is usually the basis for judging the time of picking red and striped varieties. In a majority of cases normally colored fruit of such varieties is ready to harvest if it has attained the proper size and separates readily from the spurs. Fruit is usually not ready to pick when it clings to the spurs so tightly that the stems are pulled out or the spurs broken.

Red color is not always a reliable index, as the amount of color varies with the season, the size of the crop, the vigor and age of the tree, soil conditions, and other factors. Frequently a crop of pale fruit is allowed to hang so long in an attempt to secure good color that it is harvested in an overripe condition.

A more reliable indication of maturity is the ground color, which, when the fruit is ready for picking, should be turning from the clear green indicating immaturity to a whitish or greenish yellow.

With yellow, green, and russet varieties color can not be used to determine maturity. Such varieties are generally ready to pick when they have attained the proper size and the stems separate readily from the spurs. It is generally believed that the brown color of the seeds indicates full maturity, but this is not a reliable index, as it is common to find colored seeds in immature fruit. It is certain, however, that the fruit is not ready to pick before the seeds turn brown.

Fruit that is harvested in an immature condition is inclined to scald in storage and in extreme cases may shrivel; on the other hand, if it is allowed to become overripe on the trees the length of time it will keep in storage is reduced greatly. The grower must study each variety to get the best results in storage and in the market. An exception must be made in the case of summer apples, as they are not intended for storage. It is sometimes customary to thin out the larger apples of summer varieties for cooking purposes as soon as they become large enough to meet the demands of the market.

NUMBER OF PICKINGS

Most growers in all sections remove all of the fruit from the trees at one picking, although some make two or more pickings during the season, especially when the fruit is not uniformly of good color, but is otherwise of high quality. The advisability of making more than one picking depends upon the extent to which the size and color of the fruit are affected by the load. The apples on the outside of the tree, especially the larger and better-colored specimens, are removed by the first picking to permit the limbs to lift and expose the uncolored fruit to the sun. This thinning also tends to bring about an increase in size of the fruit remaining on the trees. In the course of a week or 10 days the second picking is made, when the remainder of the crop usually is removed.

Two pickings are more expensive than one because of the additional time required to remove the fruit, though the increase in the market value of the crop often justifies this practice. But if the crop is of low quality because of various blemishes, the value of the fruit usually is not sufficient to warrant the extra cost of more than one picking.

METHOD OF PICKING

In picking apples the stem should be separated from the spur either by giving the fruit a slight rotating motion combined with a sharp upward twist or by exerting a slight pressure with the thumb or forefinger at the joint of the stem and spur, just as the fruit is pulled. The stem should not be torn out, as apples which have been skin broken in this way are more subject to decay in storage.

If twigs or spurs are pulled off with the fruit they are likely to cause stem punctures during the hauling and packing operations, and since fruit is borne on the same spurs year after year, subsequent crops may be reduced. Some varieties lose their spurs very readily even where reasonable care is exercised by the pickers, but growers should insist that these spurs be removed from the fruit before it is placed in the picking receptacles even if the speed of the work is reduced. Satisfactory results are seldom obtained unless the work of each picker is inspected from time to time by the grower or a competent foreman.

PICKING UTENSILS

Canvas sacks of various kinds and half-bushel baskets of the round type are used almost exclusively as picking receptacles for apples. In recent years the use of picking sack has increased rapidly, until now it shares equally in popularity with the basket. It is generally advantageous to use both in removing the crop, as baskets are especially convenient for gathering fruit near the ground, whereas sacks can be used to advantage only when the picker stands upright. Hamper baskets serving as picking utensils are used extensively in the Delaware and New Jersey apple sections. Tin buckets with drop bottoms of canvas and several other patented receptacles designed to facilitate the emptying process are much used in certain localities, and ordinary metal buckets are used to a limited extent.

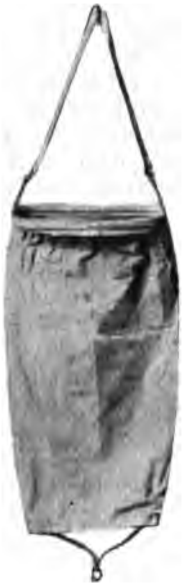
FIG. 1.—Drop-bottom canvas picking sack

Picking sacks vary widely in design and in material. In the Potomac Valley region and in Virginia, many growers use a homemade sack of burlap which holds about three-fourths of a bushel. These sacks can be made easily and quickly from a burlap bag with comparatively no expense, and for this reason are used by some growers in all sections; but because such bags must be inverted to be emptied, which usually increases the amount of bruising, they are generally recognized as less desirable than the drop-bottom type.

The drop-bottom canvas sacks (fig. 1) holding about one-half bushel are equipped with straps that fasten them securely in front of the body and hold them in place as the picker is working from the ladder. The sack consists of a canvas tube held open at the top by a wire frame. The bottom of the tube is equipped with a snap or with rings so that the sack may be closed by folding up the tube and attaching it to a ring or hooks, as the case may be, on the front of the bag. These sacks are more convenient than baskets because they are held in place in such a way that pickers have free use of both hands. For this reason they can be used to advantage where speed is an important consideration. Their chief disadvantage lies in the greater possibility of bruising the fruit as the picker walks about or presses the sack against the ladder or branches.

Round half-bushel picking baskets, used in all of the eastern apple-growing sections, usually are made from staves, and are equipped with wire bails or wooden handles. The rigid sides of these baskets protect the fruit from pressure and in harvesting tender varieties this feature is essential. Pickers have a tendency to place the baskets in a crotch of the tree or to hook them over a limb and to toss the fruit into them from a distance of several feet, causing severe bruises and often broken skins. If the baskets are padded or lined with corrugated paper the fruit is protected to a considerable extent from such injury. Where ladder work is being done the baskets should be fitted with an S-shaped hook that enables the picker to move them frequently and use both hands for picking.

The proper method of emptying baskets or sacks should be impressed repeatedly upon the picker's mind. In emptying either, care should be exercised to avoid dropping the fruit. For example, if baskets are emptied into lug boxes the basket should be lowered to the bottom and inverted gently, or the box should be tipped so that the fruit rolls directly from the basket gently down the side of the box. Drop-bottom sacks are so constructed that fruit can be emptied without bruising if the bottom of the sack rests on the bottom of the container when it is opened.

It is evident that all of these utensils have uses to which they are peculiarly adapted, and one can not be recommended to the exclusion of the others. The successful use of any particular picking utensil is largely a matter of management, and two different types can often be used to advantage.

LADDERS

Several different types of picking ladders are in common use. The ordinary straight ladder is still used extensively in most sections, but is being displaced rapidly by improved types. The chief disadvantage of the straight ladder is the top-heavy tendency which makes it difficult to set it securely against the smaller branches without breaking them and knocking off fruit. One desirable modification of this ladder has a broad base and tapers toward the top. This construction gives a better distribution of the weight and makes it correspondingly easy to handle.

The pointed ladder is probably most satisfactory, as it is lighter and can be placed against a limb or fork that would not support a common straight ladder. For picking in the tops of high trees extension ladders are desirable, as they make it possible to gather fruit which could not be reached in any other way.

The use of such ladders is preferable to having the pickers climb the trees. Climbers in heavy shoes are likely to split the crotches and peel the bark. It is generally necessary to gather part of the fruit borne in the center of the tree by climbing, and where this is done much injury to the tree may be prevented if the pickers wear rubber-soled shoes or leather shoes without heels.

Stepladders of various kinds are especially satisfactory in harvesting fruit from small trees and from the lower branches of large trees. The most desirable types are wide and flaring at the bottom, narrow at the top, and supported with but one prop. Such ladders can be "set" quickly and securely, if the ground is level, without knocking off the fruit as do the long ladders which are leaned against the trees.

HANDLING THE FRUIT FROM TREE TO PACKING TABLE

Where the crop is packed over tables that are moved from place to place in the orchard the fruit usually is carried in the picking utensil to the packing table. It is common practice for pickers to carry the fruit, but in so far as possible this should be avoided, because it is both expensive and inefficient. Certain members of the crew should be assigned to the task of carrying the filled baskets to the table and furnishing the pickers with empty baskets. These men carry at least two full baskets of fruit from the tree to the table, whereas the picker makes the trip with one. If picking sacks are used, the fruit is carried to the tables in lug boxes which when full are too heavy to be handled by women or boys. The carriers also save much time for the pickers who are working on ladders or in the trees by taking the full baskets, lowered by means of a rope, and attaching empty ones. This makes it unnecessary for the picker to climb down to empty his basket.

Where the packing is done at a central packing house or at one permanent location in the orchard, the fruit is delivered to that place in boxes, crates, barrels, or baskets. Crates and boxes are preferable, as they are more conveniently handled and they may be stacked securely in storage or during hauling without bruising the fruit.

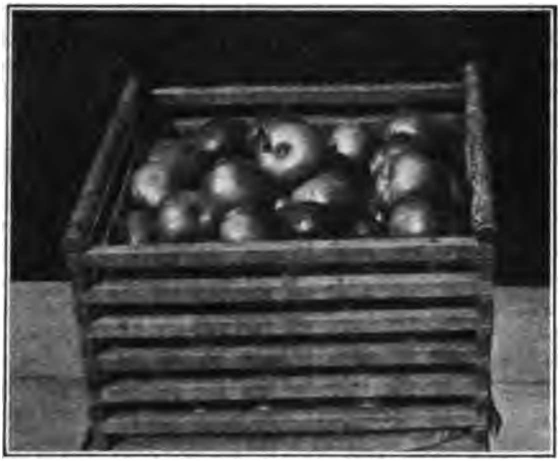

FIG. 2.—Slatted folding crate widely used as a field carrie

A durable slatted crate which holds about a bushel is extensively used. Such a crate, illustrated in Figure 2, has a solid bottom and the grooved top strips and half-round bottom strips fit together when the crates are stacked and prevent them from shifting. The best lug boxes, holding about a bushel, are made of heavy material, with handholes at the ends and cleats across the top.

Time is saved if the pickers are at all times provided with an abundance of field crates to receive the picked fruit. The grower or foreman should see that these are distributed to the proper points in advance of the crew.

BASIS OF PAYING PICKERS

The speed of the work undoubtedly can be increased by paying the pickers on a piecework basis instead of a straight day wage.

The piecework system may be employed advantageously where there is a labor shortage or where there is low-quality fruit, heavy dropping, or any other circumstance demanding the quick removal of the crop. It is the exceptional picker who will do his utmost when paid by the day, and the exceptional one who will not pick more when paid by the piece. The pickers generally make better wages by this plan, and any tendency toward carelessness can be avoided by strict supervision. If the grower is not able to superintend the pickers, the damage resulting from carelessness may more than offset the advantage of the increased amount picked. It is possible to check up accurately on the work done by each picker by requiring that a check bearing an identifying number be placed in each basket or box picked. If the wages are adequate and the supervision is careful enough, the piecework system can be employed successfully in picking crops of high quality.

GRADING AND PACKING

In small orchards, under favorable weather conditions, apples are often packed in the open with portable equipment, but in sections where unfavorable weather generally prevails during the harvesting season the fruit from both small and large orchards is more often packed in central houses, tents, or sheds.

If the fruit is to be held for any length of time it should be placed under proper conditions of storage; otherwise it should be packed as soon as possible and removed to storage. In producing sections toward the South the common and most desirable practice is to pack the fruit as soon as it is picked and remove it to storage as quickly as possible.

Use of packing houses has increased rapidly during recent years and is a development in the right direction. They are used in both large and small orchards, and many growers with only a few acres of apple trees have their packing done in a house or shed. This practice affords the following advantages: (1) Any accumulation of unpacked fruit is sheltered, and the grading and packing can be continued without interruption in spite of unfavorable weather; (2) equipment, packages, and fruit are protected from the weather at all times; (3) use of a house encourages the installation of sizing machinery and other labor-saving devices which can not be used to advantage in the open; and (4) efficient organization of labor is simplified by having all of the work done in one place; there is no necessity for the confusion and loss of time which is caused when the outfit is moved frequently.

The tendency among the larger and more progressive growers in all sections is toward the use of packing houses equipped with machinery. In small orchards, when the climatic conditions are especially favorable, it may be advisable to pack in the orchard, but in most instances the use of a house or shed of some sort will insure better results.

Many growers contend that packing houses are not desirable in orchards located on rough, hilly land because of the difficulty of hauling the loose fruit. Some of the largest and most successful houses operated at the present time are located on hilly land. They have the advantage of avoiding the difficulties encountered where the fruit is carried to the table and the equipment is moved from place to place on steep hillsides.

Packing houses are particularly desirable under such conditions as are found in the upland orchards on the steep sides of the Blue Ridge Mountains. In some of these mountain orchards growers have so much difficulty in moving their packing equipment that they select a central location for their packing operations and remain there. Practically all growers who have used packing houses are emphatic in their indorsement of their use as compared with orchard packing.

GRADING TABLES

Two types of grading or sorting tables are used almost exclusively where the fruit is graded in the orchard, and are used to a large extent in packing houses. These are the apron table and the canvas or burlap table.

APRON TABLE

The apron table or a variation of this type is commonly used in all sections. The table shown in Figure 3 is typical of the kind used when packing is done in the orchard. The bed of the table, which is slatted in such a way that trash falls through, is inclined so that the fruit as it is graded rolls to the lower end, where, upon the opening of a stop or trap, it is lowered by means of an apron into the barrel. The end of the table where the packing is done tapers to an opening approximately 1 foot in width.

A 50 or 75-bushel hopper or bin into which the fruit is emptied directly from the orchard wagons is sometimes attached to the apron table when such equipment is used in a packing shed. This arrangement has the advantage of furnishing a continuous supply to the table and saves handling the field containers in the packing shed. Unless the bin is kept nearly full, the fruit is almost certain to be bruised in rolling down the necessarily steep incline to the bottom. The weight of the fruit in the bin also makes it difficult to regulate the feeding and the apples often rush by the sorters faster than they can be graded properly.

The usual method where two grades are packed is to remove the culls and the second-grade fruit into baskets or barrels and to allow the first-grade fruit to "run" over the table. When one of two grades is sorted out the sorters should always remove the grade which constitutes the smaller proportion of the fruit, in order to reduce the amount of handling to a minimum and to allow the grade constituting the larger part to be run over the apron into the barrel. The man who packs the barrel is usually responsible for the maintenance of the grade. He has charge of the crew at his table, and in addition to checking up the work he supplements the sorting by going over the fruit as it passes into the barrel.

This type of table is popular because the work can be done rapidly. It is not altogether satisfactory, as the fruit frequently crowds past the sorters in a way which encourages carelessness. The actual sorting takes place as the fruit is pushed or rolled along to the end of the table, which is frequently kept so full that it can not be thoroughly inspected. Only with very careful management can the grades be maintained by the use of this table, especially if the fruit is not uniformly of good quality.

CANVAS OR BURLAP TABLE

The second type of grading table is made of canvas or burlap stretched over a four-cornered frame longer than wide. It is not fitted for running the fruit over an apron into the barrel as with the apron table. The apples must be sorted by hand into baskets, in which they are lowered into the barrels. The advantage of this table is that all of the apples are subjected to careful inspection as they are removed by the sorters. Although as a rule this is a slower process than that of handling the fruit over an apron table, the sorters with practice soon become skilled and are able to handle the fruit very

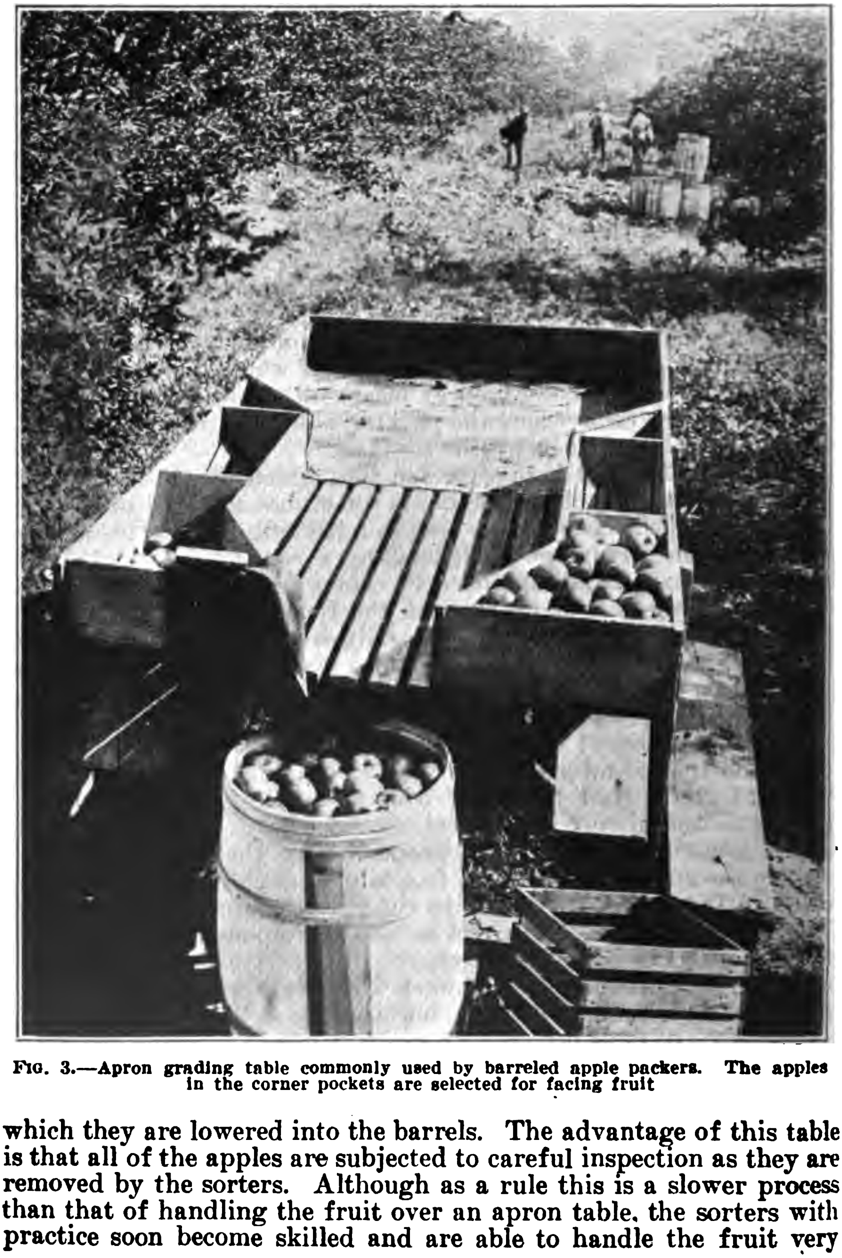

FIG. 3.—Apron grading table commonly used by barreled apple packers. The apples in the corner pockets are selected for facing fruit

rapidly. When as much as half of the fruit must be removed from the apron table in the process of grading the same work could be done as rapidly and more accurately over the canvas-top table.

Care must be exercised in the management of either type if the best results are to be obtained. In the case of the apron table the fruit is often bruised by crowding it along with the picking baskets as they are being emptied. With canvas-topped tables the sorters should be cautioned about throwing the apples into the baskets into which the fruit is being graded. Injury from this source may be avoided to a considerable extent by using padded baskets.

SIZING MACHINES

Prior to 10 years ago the mechanical sizing of fruit for barrel packing was generally considered impractical, although machines for the sizing of boxed apples had been used in the Northwest for some time. The most popular machine used for boxed apples sizes by weight, whereas practically all machines used for barrel packing size the fruit by measurement. Machines for sizing boxed apples are constructed to size the fruit more accurately than is necessary for barrel packing, and for this reason the capacity is very much less than that of the machines which size by measurement.

At present sizing machines are used extensively for barrel packing in all sections to meet the demand for apples that are uniform in size. The commonest practice throughout the barreled apple sections is to separate the fruit into two standard sizes—2¼ to 2½ inches, and 2½ inches and larger. Such sizing is customary whether the sizing is done with machinery or not, but it can be done more rapidly and accurately by the mechanical sizer. The use of the machine enables the grower to give more attention to the grading of the fruit, as the sorters are not concerned with the size classification. Where greater unformity is desired the machines are equipped to sort the fruit into variations of one-fourth inch, and where this is done the mechanical sizer is of even greater value, as a uniform pack may be secured with inexperienced help.

The sizing machines used most extensively for barrel packing are essentially simple in construction. They consist of two parts—canvas or roller conveying belts on which the fruit is sorted, and the sizing device proper. The fruit is delivered to the grading belt as it comes from the orchard and is sorted as it moves toward the sizer.

One of the most popular types is equipped with endless-chain belts about 2 feet wide, composed of rings of a certain size. (See fig. 4.) Two to four of these belts are used and are arranged in series so that the fruit progresses from the smallest to the largest rings. As the apples are delivered onto these chain belts from the grading belt they either drop through the rings of the first or are carried on to the next. Where two chain belts are used the fruit too small for packing drops through the first, which is usually composed of 2¼-inch rings. The rest of the fruit is carried to the second chain, composed of 2½-inch rings, through which all the apples between 2¼ and 2½ inches drop. Those remaining are carried by a short conveying belt to a packing bin equipped with an apron. This size includes all apples 2½ inches or more in diameter.

The sizing chains are inclined or otherwise arranged so that the position of the fruit is changed several times as it is carried over the rings. This is necessary to secure the measurement of the cross diameter, which is the dimension used as the basis for all sizing. Apples occasionally fall onto the sizing rings so that they are measured by the stem to blossom end diameter, which causes large and small apples to appear in the same bin. It is necessary to measure each apple by the same diameter to secure uniformity.

Another popular machine is equipped with sizing units, each consisting of an endless corrugated roller belt having round openings between the rollers through which the sized fruit passes. (See fig. 5.) These units are arranged in series, the size of opening varying for each unit. As the fruit moves along over the machine the smallest apples are sized first and the largest last. The sizing units are arranged so that the position of the fruit is changed many times as it is carried over the rollers, thus aiding in securing a uniform sizing.

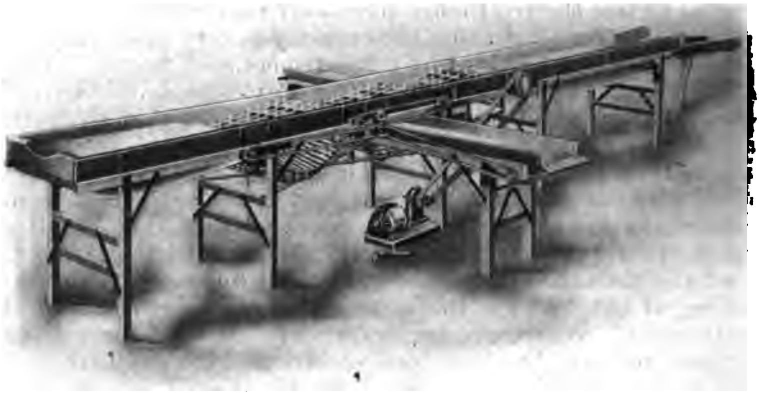

FIG. 4.—Machine equipped with sizing belts made of linked rings

In another type of machine used extensively the fruit is dropped into a series of cups or pockets, operated as an endless belt. (See fig. 6.) These cups or pockets enlarge as the fruit is carried along until the diameter is great enough to allow the apple to drop through into the bin.

In general, any of these machines will size apples satisfactorily for barrel packing. The choice of the machine will have to be made by the grower, based upon a consideration of the size of the orchard, equipment already on hand, accuracy required, and number of sizes desired. There are a number of points that growers should keep in mind in making this choice: (1) The machine must have a capacity proportionate to the size of the orchard, so that the operation can be conducted economically. In choosing between two machines, one which has a large capacity but is only moderately accurate and the other which has a small capacity but is very accurate, such as those used in connection with box packing, the former is preferable in most cases. (2) Simplicity of design and freedom from too numerous adjustments are features much to be desired. The machines that size most accurately are generally expensive, cumbersome, and fitted with numerous delicate adjustments which tend to make them undesirable for barreling operations, as barreled apples are sized not closer than one-fourth inch variations and extreme accuracy is unnecessary for this purpose. (3) An investigation should be made to see that there are no arrangements or devices that will unduly bruise the fruit. If the apples are bounced along on metal or unpadded parts, or if the construction in any way necessitates crowding or congestion, there is danger of injury, and such a machine will not be suited to tender varieties. (4) The durability of the machine is a matter of great importance. If such a machine is not substantial it will soon go to pieces when subjected to the rough handling usually given such equipment.

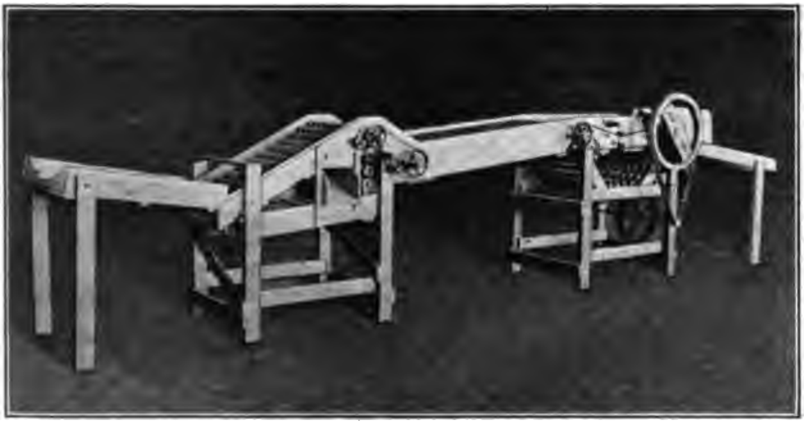

FIG. 5.—This machine sizes the fruit through round openings in an endless corrugated roller belt

ADDITIONAL EQUIPMENT FOR SIZING MACHINES

Practically all sizing machines in use at present separate fruit of one grade into various sizes, but by dividing the grading belt lengthwise with a strip or pipe and rearranging the chutes which divert the fruit from the sizing device to the packing bins, two grades may be sized at the same time. Assuming for the purpose of illustration that A and B grades are to be sized separately, the grading operation is carried on in the following manner: The field-run fruit is emptied on the belt and passes on both sides of the partition. The culls are first removed into containers provided for that purpose; then the sorters standing on the A side do not handle the A grade fruit but put the B grade across the partition, and the sorters on the B side permit the B grade fruit to pass and put the A grade across to the A side. With this plan only 50 per cent of the fruit is handled, no matter what percentage of the crop falls in each grade, except such handling as may be necessary to determine the grade.

Perhaps a better way of dividing the fruit is to divert all the fruit to one side of the partition. Where this is done the grade constituting the smaller part of the crop is sorted out and placed on the opposite side of the partition. This requires the handling of a smaller percentage of the fruit than the other method, unless the crop is evenly divided between the two grades.

In most commercial operations the second-grade fruit is not separated into various sizes, but all of it above a certain minimum diameter, usually 2¼ inches, is packed together. Instead of following the usual practice of sorting out this grade into baskets or barrels, a canvas conveyer 5 or 6 inches wide, placed about 18 inches above the table, may be used to advantage in carrying the fruit to a side bin at the end of the machine.

Efficient disposal of culls is a point which is commonly neglected. Often an accumulation of this fruit on the packing floor is allowed to interfere with the operations of the crew. In many houses the culls can be conveniently carried to the basement by canvas chutes. They must be removed later by elevators, or the house may be so constructed that it is possible to drive directly into the basement. Where there is no basement, conveying belts may be used to carry the culls to elevated bins, from which they can be removed through a trap into wagons.

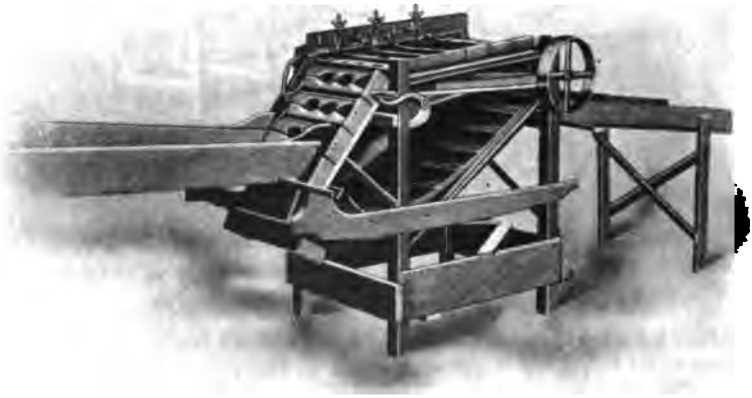

FIG. 6.—This machine sizes the fruit through cups which enlarge as the belt moves along

The method of feeding the fruit to the sizing machine is another point to be studied carefully, as it influences directly the total daily output and consequently the cost of operation. In the first place, it should be possible to supply a continuous flow of fruit to the sizer without any tendency toward crowding or bruising, and second, it should not be necessary to lift the filled containers to any considerable height from the floor to empty them, especially where the loose fruit is hauled in barrels. Unnecessary lifting may be avoided by elevating the receiving platform or floor about 30 inches above the main packing floor, or to a little less than the height of the sizing machine, thus permitting the emptying of the fruit at about floor level. With this feature of construction the feeding can be still further facilitated by installing a belt 10 to 15 feet in length to receive the fruit. This belt ordinarily should extend along the receiving platform at right angles to the grading belt, thus making it possible to empty the loose fruit at any point along the line. Extended observations indicate this to be the ideal arrangement.

Another method of feeding consists of pouring fruit into a hopper on the floor level, from which it is carried to the sorting belt or sizer by means of an elevator belt. This method is in rather common use in sections where the loose fruit is hauled in barrels, and in some houses has given satisfactory results; however, without careful management there is a marked tendency to bruise the fruit. In the first place, the man emptying the barrels may allow them to rest partially upon the fruit in the hopper; then, when the hopper is full the elevating belt frequently carries several apples halfway up the incline between the lugs, and this fruit is generally bruised by rolling back into the hopper. The hopper method is somewhat slower than the belt running on the level of the machine, as it is obvious that a feed belt carrying fruit on lugs placed several inches apart can not have as great a capacity as one running on the level. If a hopper is used, it must be properly padded.

POWER

The small machines can be operated by hand power, but in nearly all cases the use of a gasoline engine or an electric motor is preferable. It is generally best to place the engine or motor in the loft or basement or under a shelter outside the building, in order to leave the packing-house floor clear for the operation of the crew.

The speed of the machine needs to be regulated carefully, as the accuracy and care with which the apples are handled are largely dependent upon the speed of the belts and chains. Practically all machines when run too rapidly are inaccurate and cause an excessive amount of bruising. When the conveyer belt delivers the fruit very rapidly to the sizer a congestion may result from the inability of the sizing device to size all of the apples delivered on it. When it is desirable to increase the output of the machine the fruit should be supplied in an uninterrupted flow rather than by increasing beyond normal the number of revolutions of the drivewheel.

CONVEYERS

Two types of mechanical conveyers are used extensively in packing-house operations—the endless chain or belt operated by machinery for conveying loose fruit or light packages, and the roller type for conveying filled packages by gravity. Chutes may be used to advantage to convey fruit (especially culls) or packages to a basement or lower floor. The belts are made of heavy canvas or rubber fabric and vary in width as desired. A smooth board is supplied as a floor over which the loaded part of the belt travels so that it will not sag or fold under the weight of the fruit. Belts or chains fitted with lugs and supported by a trough are used where the fruit is elevated or lowered.

The roller conveyers provide a convenient means of moving fruit in packages, either packed or unpacked, from place to place on the packing floor. This type of conveyer is especially useful in connection with the unloading of containers of fruit from the orchard. They are delivered to the end of the conveyer from the wagon and are carried quickly to any part of the house. Where the fruit is to be carried from one point to another within the house this operation may be performed more rapidly and with less labor expense by the use of gravity conveyers. In most cases two men with this equipment can do the work of four without such equipment.

GRADING LAWS

The enactment of grading laws for apples is a development of comparatively recent years. The first definite attempt toward securing the passage of such legislation was initiated in 1907 by a number of prominent growers, shippers, and dealers, who, after a struggle lasting for several years, finally in 1912 secured the passage of the Federal law commonly known as the Sulzer bill. This law served the valuable purpose of awakening and crystallizing public sentiment throughout the country favoring legislation which would stabilize the barreled apple industry by eliminating fraudulent and deceptive packing and by establishing a uniform basis for buying and selling. In 1913 the State of Maine passed a compulsory apple grading law which was followed by similar legislation in 18 States. Apple grades are provided in Canada by the Canadian fruit act, 1923.

For several reasons the State laws have not been wholly successful in obtaining the desired results. In the first place, the requirements of the laws have not been practical in all cases; many were enacted hurriedly, and most of them contained certain provisions which are not consistent with commercial practice. Second, the extent to which these laws have been enforced in the different States has varied so greatly that in many instances the grade terms have come to have little or no value. Furthermore, the fruit from practically all of these States frequently appears in the same markets, and the use of identical grade terms having different meanings in the different States has in a way defeated the purpose of the laws in that no grade term has ever stood for a standard pack. In spite of these objections, however, a State law that is practical in its specifications and intelligently enforced will carry with it many advantages.

In 1918 tentative United States grades were first recommended. In 1924 they were promulgated by the Secretary of Agriculture to be the official standards of the United States for the inspection and certification of barreled apples.

These grades are now optional in Illinois, New York, and Pennsylvania. They are the only official grades in Ohio, South Carolina, New Jersey, and North Carolina, the two latter States adding color requirements for additional varieties not listed under the United States grades. In addition to the States just mentioned, Delaware, Maryland, Tennessee, West Virginia, Virginia, Wisconsin, and Kansas have used the United States grades for shipping-point inspection, although not officially adopted by these States.

PACKING

THE BARREL

The minimum capacity of the apple barrel has been fixed by an act of Congress at 7,056 cubic inches, or somewhat over 3 bushels, and the "short" barrel is a thing of the past. Half and third barrels are permitted by this law, but they are used by growers only in rare instances.

Several kinds of wood are used in the manufacture of barrels. Oak, pine, poplar, and birch are used chiefly. Barrels are usually coopered with six hoops, but in certain localities growers bind their barrels with eight hoops, using four instead of two quarter hoops. This practice insures greater strength, as the single quarter hoops are often broken in handling and a barrel without quarter hoops is likely to be badly sprung. Barrels fitted with double quarter hoops are stacked more solidly on the bilge, as they are prevented to a certain extent from rocking. In certain parts of New England iron hoops have been adopted and are generally favored. They are forced into place and will hold securely without nailing in practically all cases, but the safest procedure is to secure the top hoops with two or three nails and avoid the possibility of their working loose. Wire quarter hoops are commonly employed by some eastern growers, who claim that they fit more tightly and do not break as easily as do the wooden hoops, but if wire hoops are broken or become untwisted at the joint it is almost impossible to repair them without special equipment.

Two grades of barrels are made. The chief difference between them lies in the kind of wood and the workmanship. The No. 1's are made from the better woods and more care is exercised in the selection of the hoops than in No. 2 stock. The heads of the No. 1's are usually made from two or three pieces, whereas those of the No. 2's are frequently composed of four pieces. Barrels of the first grade are probably more economical on the whole, as those of the second grade frequently break and cause extensive loss in handling.

The barrel is generally delivered to the grower with both heads and all of the hoops in place, but with none secured by nails. This permits storing indefinitely without danger of warping. Upon removing the barrel from storage one head is nailed in and liners, which are thin gum strips, are tacked over the ends of the pieces that make the head to prevent them from breaking out of the croze ring. The quarter hoops are secured by two nails on opposite sides of the barrel. The other head is then removed and placed in the bottom of the barrel.

FACING

The first step in packing a barrel is that of facing, or arranging the first and perhaps the second layer of apples in concentric rings on the bottom of the barrel. (Fig. 7.) Practically all growers use the single face, consisting of one layer, but the double face is used occasionally, especially for fancy fruit. The fruit is packed stem down except in the case of the second layer of the double face, which is often packed on the cheek. When the barrels are single faced they are backed up with a layer of "spotters," or apples dropped into the spaces between the apples of the face, so that the red cheeks face downward and show through to the best advantage when the barrel is opened. The "spotters" also keep the apples of the face in place when the remainder of the stock is poured into the barrel. The double face has no advantage over the single face and tends to create a false impression of the rest of the contents.

The advantages of the single face are three fold: (1) It legitimately increases the attractiveness of the pack and draws the attention of prospective buyers more readily than if there were no order of arrangement. (2) By carefully placing the first two layers in the bottom of the barrel a large amount of bruising is avoided that might occur if the apples were dropped into place carelessly. (3) By placing the apples evenly over the surface of the head and then reinforcing them by spotters each one shares an equal amount of the pressure of the head and the amount of bruising is thus reduced to a minimum.

The chief objection to the practice of facing is that as a general rule only those apples of superior size and quality are considered desirable for this purpose. Unreliable packers have resorted to the practice of facing with fruit far above the average quality of the barrel in order to deceive the buyer. There has been so much dissatisfaction and loss as a result of this method that a strong sentiment has developed among some growers and dealers in favor of enacting legislation requiring the face to represent fairly the average content of the barrel.

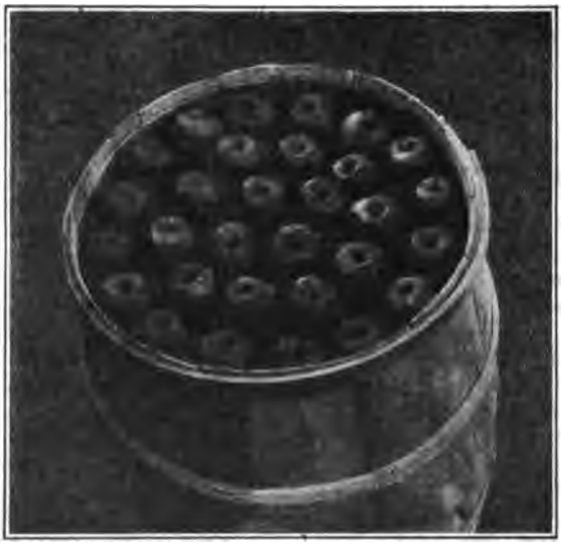

FIG. 7.—An excellent face made with 2¾-inch apples

FILLING THE BARREL

After the barrel is faced it is moved to the packing bin or grading table, where it is filled. Two methods of filling the barrel are used almost exclusively because they make it possible to lower the fruit into the barrel with a minimum amount of bruising. Filling is usually accomplished by the aid of a canvas or burlap apron attached to the grading table or packing bin, but it may be done equally well by the use of half-bushel baskets which are lowered into the barrel and emptied.

Where the slatted inclined table is used, or where a sizing machine sorts the fruit into packing bins, the apron attachment is employed;

but where the fruit is emptied from field crates onto canvas-topped tables and is hand sorted into half-bushel baskets, it is emptied directly from these baskets into the barrel. Either method is satisfactory if the packers employ a reasonable amount of care.

In addition to being carefully filled, a barrel must be packed tightly so that shrinkage and handling in transit or storage will not cause the pack to become slack. To insure a tight pack the apples must be settled thoroughly as they are placed in the barrel. This is done by racking.

"Racking" is a term used to describe the forced settling of the fruit by rocking a partially filled barrel back and forth in a sharp, jerky manner. To produce a tight pack the barrel must be racked after the first bushel is poured in upon the face, and again as each half bushel is added until properly filled for heading. The height of the fruit above the top of the barrel before heading varies ordinarily from one-half inch to 2 inches, depending largely upon the thoroughness of the racking.

Under no circumstances should a grower omit racking and resort to overfilling as a means of making a tight pack, for no barrel which has been overfilled will pack as tightly as if it had been racked thoroughly to a height nearly level with the top. Pressing an overfilled barrel causes severe bruising all through the pack but does not result in a thorough settling of the fruit. Though apparently tight when pressed, it will settle later and become slack. From all the evidence available it is apparent that one-half to three-quarters of an inch above the top of the barrel is a sufficient height for the contents of any properly packed barrel.

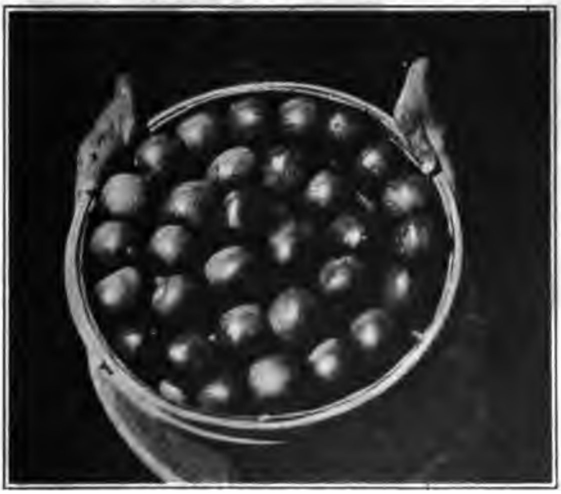

FIG. 8.—A good example of "ring-tailing"

TAILING

Before pressing the head into place it is important to level the apples on the "tail" so that the pressure will be distributed equally. This is accomplished in one of two ways, either by roughly leveling off the high places or by arranging all of the apples exposed into a plate formation similar to that of the face. The first practice, which is in most common use, is known as "jumble tailing" and the latter practice is known as "ring tailing" (fig. 8). The "ring tail" is used to increase the attractiveness of the better grades. It also enables the grower to make a tight pack without injury from the pressure of the head. It is rather difficult for an inexperienced hand to arrange the ring tail successfully, but a week's practice should enable the average person to put out 125 to 150 barrels a day.

The process of tailing is greatly facilitated by the use of the "follower" or "shaker," which is a heavy circular piece of wood made from 2-inch planks with a handle on top and thickly padded on the underside. It is fitted into the head of the loosely filled barrel. Held tightly in place during the racking operation, it causes the fruit to settle with an even surface. The follower is applied to the full barrel if the jumble tail is used, but if the pack is ring tailed it is applied before the barrel is quite full, so that the last layer of apples will bring the contents to the desired height before heading. The follower is universally used and favored, as it expedites both methods of tailing.

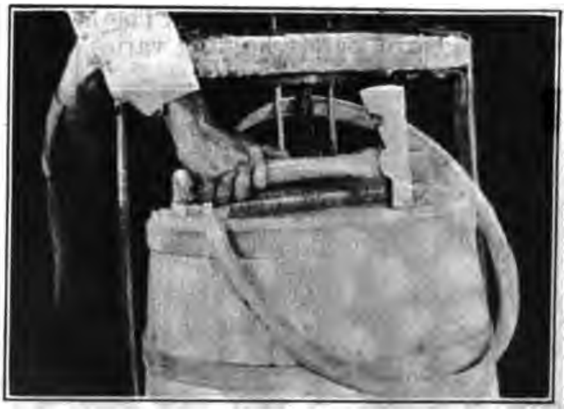

FIG. 9.—The screw press used for heading barrels

PADS

Corrugated pads are used by practically all growers to reduce the amount of bruising caused by pressing the head into place. If two pads are used one is placed under the face and the other over the tail; if only one is used it may be placed on either end, but it will serve best if placed on the tail end, especially when the apples are jumbled and exposed to the rough and frequently uneven pieces of the head, which cut and bruise the fruit when the pressure is applied.

BARREL PRESSES

The type of press used to head the barrel is a matter of considerable importance, since there are two principles of construction involved, one of which is outstandingly superior to the other. The pressure in one case is applied by means of a screw and in the other by means of a lever.

The screw press, shown in Figure 9, although probably slower in operation than the lever press, is favored by a large majority of the apple growers, as it enables the packer to head the barrel with a minimum of bruising. This is possible because the pressure is exerted as a steady force which adjusts the head by degrees, and the severe shock that usually accompanies the use of the lever is avoided. Where the lever type of press is used it is not uncommon to see the header jump on the lever and bring the head into place with a crash, causing severe bruises and skin breaks.

An attachment to the screw press which has been recently introduced and which is being adopted rapidly consists of a platform on which the barrel rests when it is headed. When not equipped with such a platform the press hooks onto the bottom of the barrel by means of iron strips that extend down each side. This arrangement is open to the serious objection that it is likely to break the bottom hoops as the head is pulled into place, especially if the barrels are old or damp, thus materially weakening the barrel for subsequent handling.

NAILING

When the head has been pressed into place and the upper hoops have been tightened the barrel is ready to be nailed. The nails should be driven through the top hoops at an angle of about 45°. Nails driven horizontally into the ends of the pieces that make the head frequently split the wood and do not hold as securely as when driven at an angle. From six to eight nails will hold the three and four piece heads in place. The use of more is a waste, especially when as many as 12 to 15 are used. If barrels are to be handled roughly or are to be transported long distances they should be additionally strengthened by the use of "liners" nailed over the ends of the headpieces (fig. 10). Use of liners tends to prevent the head from springing out of the croze when the pack is submitted to a severe strain.

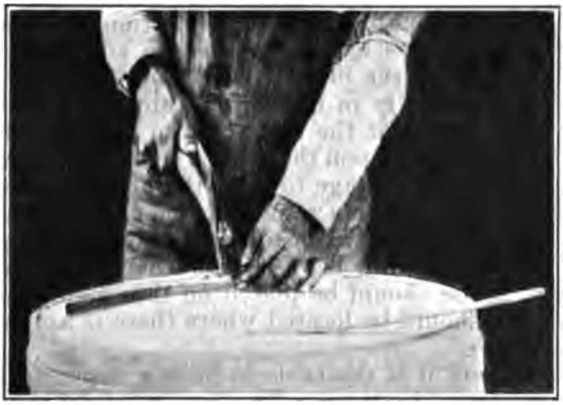

FIG. 10.—Nailing on the head liners

PACKING HOUSES

Many types of structures are used for apple-packing operations, ranging from tents and sheds to permanent buildings equipped with packing machinery. The most desirable type depends largely upon the size of the orchard and the section of the country in which it is located. In many places where the individual orchards are too small to justify the erection of modern packing establishments, such houses have been built and operated successfully as community enterprises. Such a plan has a much better chance of success if the roads in the district are good and the orchards are not too widely scattered. The community house enables the small grower to profit by the division of labor and the increased efficiency of labor-saving machinery, and the standardization of pack is of marked advantage in disposing of the crop.

Packing houses can be discussed best on the basis of their equipment. Those having no labor-saving machinery other than the ordinary implements used to fill and head the barrel are in one class; those equipped with sizing machines, gravity and belt conveyers, and other mechanical devices constitute another class, regardless of the amount of floor space or the construction of the building in either case. A large tent or shed filled with apron tables all operated independently of each other, so that there is no division of labor among the hands employed, can not reasonably be classed with one that is prepared to increase the number of barrels packed per man, no matter how much greater is its total output.

The equipment of a house operating without machinery differs little from the usual field layout, and for that reason this bulletin is concerned primarily with the establishment of a modern packing house fitted with labor-saving devices designed to facilitate the various operations and to reduce the packing costs.

LOCATION

In choosing the site for a packing house there are a few points which, if kept in mind, should enable anyone to select the proper location without difficulty. A community house, practically without exception, should be located on a railroad to avoid the added expense of hauling the loose fruit to the packing house and the packed fruit to the railroad. This is particularly true where the packing house is built in connection with the storage house. Individual houses may be located to advantage on the railroad if the roads from the orchard are good, but if they are not there is too much difficulty in moving the unpacked fruit without injury.

If located at the orchard, the position of the packing house depends largely upon the lay of the land. If the land is level it is sometimes an advantage to have the house in the middle of the orchard, thus reducing to a minimum the aggregate distance for hauling the unpacked fruit. When the road to the shipping station is good and permits hauling heavier loads than can be pulled through the orchard the house should be placed on this road, and in a hilly orchard the house should be located where there is a minimum amount of uphill hauling.

Where it is desirable to have a basement storage, advantage may sometimes be taken of a slope to build a house with the receiving platform level with the wagon beds on the upper side and with the floor of the basement level with the wagon road on the lower side. Under this arrangement the fruit can be conveyed to the basement by gravity and removed without the expense of operating elevators.

LIGHTING

In the construction of a house or in the remodeling of an outbuilding for use as a packing plant provision for an abundance of light is of first importance, for the thoroughness of the work is severely impaired where the fruit is partially in shadow. Light may be admitted into the packing house in several ways. Skylights and windows high up on the walls in sufficient number to light the interior thoroughly offer the most satisfactory lighting arrangement. Where the house is constructed with a loft skylights can not be used except by the addition of light shafts. Light must be admitted from the sides of the building, either through sliding doors and windows or through hinged doors that swing upward and outward. A large house that depends upon side illumination is likely to have a dark region toward the center, even though the sides may be entirely open, but if all tables and conveyer belts used for sorting are placed along the sides of the house the light will fall directly on them.

Light shafts are sometimes used to increase the amount of natural illumination, and white paint is applied to interiors to intensify and reflect whatever light is available. If artificial illumination is used special care should be taken to have the lights for the sorting operations arranged so that there will be no shadows on the fruit. For this purpose reflectors in the shape of an inverted trough fitted with electric bulbs can be suspended over the grading belts or tables.

STORAGE ACCOMMODATIONS

Every packing house should have adequate space for storage of empty barrels and for temporary storage of loose fruit from the orchard and packed fruit intended for storage or shipment.

If 50 per cent or more of the barrels needed for the crop can be stored in the house at one time, there is little danger of shortage and suspended operations during the height of the season, which frequently happens when the barrels are secured from day to day from a local cooperage. With this in mind some of the growers in the East who pack out the largest crops use a barn or attached building for barrel storage and put in a large reserve supply.

A loft or second story immediately over the packing floor constitutes the most satisfactory barrel storage. If barrels are stored on the packing floor the house must be unusually large to accommodate them or congestion and confusion result. Where the floor is only large enough to accommodate the packing operations, the storage of empty barrels except the necessary working surplus, takes up space which can be used to better advantage for the accumulation of loose and packed fruit.

The floor space adjacent to the feeding belt should be devoted to the storage of enough field-run fruit to supply the crew for several hours or longer, so that temporary interruptions in the delivery of fruit from the orchard will not affect the continuity of the packing operations.

It is also well to provide additional room for at least one day's output of packed fruit awaiting movement. A shortage of cars or of hauling facilities frequently prevents the removal of the fruit as rapidly as packed, and space should be provided to accommodate such fruit temporarily without hindering the packing operations. This space may be provided on a covered platform which furnishes protection from the rain and sun.

VENTILATION

Another important consideration is adequate ventilation throughout all parts of the house, especially those parts intended for the storage of fruit. Where the storage room for ungraded fruit, culls, or packed fruit is inclosed, abundant ventilation is needed. The main packing room seldom lacks this feature because of the number of windows required for proper lighting.

SUGGESTED FLOOR PLANS

It is impossible to give here the exact specifications for building packing houses, but with the aid of several suggested floor plans certain desirable features of construction and arrangement for the convenient and economical handling of the fruit may be pointed out.

The type of house suggested in plan 1 is designed for handwork operations where the ordinary apron or canvas-top tables are used. (See fig. 11.)

The dimensions of this house are 30 by 60 feet, which, with a double apron table, should provide for an output of 200 barrels per day. For larger operations the floor space and number of units may be increased indefinitely. The house is divided into two sections, one to be inclosed for empty barrel storage and the other to be left open on two sides for the packing room. The space available for the packing operations is increased by the addition of two covered platforms 5 feet wide extending along the open sides of the packing room. The driveways should be built so that the wagon beds will be on the level with these platforms to facilitate loading and unloading. The fruit is received on one platform and passes in an orderly way through the packing operations to the other side of the house, where it is loaded on the wagons. The arrangement of the equipment is such that the work can be done without any unnecessary moving around or waste motion. The extra space in the packing room is provided for unpacked and packed fruit.

Plan 2 shows a house equipped with three grading machines which have a total capacity of approximately 1,200 barrels a day. (See fig. 12.) This arrangement is particularly well adapted to a community house where fruit is packed for a number of growers. The feeding belts marked A are a very desirable feature, as fruit may be emptied on the machine from practically any point along the receiving platform. The fruit passes over the sizing chain B, where the fruit smaller than the minimum size for packing is dropped into a cull chute C leading to the basement. The remainder of the fruit is then delivered to the grading belt D, where the culls are removed by the sorters and dropped into another branch of the cull chute. The grading belt may be divided as illustrated in the middle machine shown in this plan so that two grades may be sized simultaneously. In this case the sorters who work on both sides of the grading belt divide the fruit into two grades, which are placed on opposite sides of the division board E. The first size, which usually consists of all fruit from 2¼ to 2½ inches in size, passes through the rings marked F into the bins G and GG. But the fruit 2½ inches in diameter and larger is carried up the elevator belt H onto another belt I, which delivers the B fruit into bin J and the A fruit into the double bin K. This bin is fitted with a gate or deflector L, which when open fills the first compartment and when closed allows the second compartment to fill. Two bins are provided for this fruit because the bulk of the average crop runs A grade, 2½ inches and larger, and there must be bin space enough to accommodate all this grade when operating the machine continuously.

The end machines illustrated in this plan are not equipped to size two grades. Fruit of B quality is removed from the sorting belt into baskets and packed in the space behind the sorter, while the A fruit from 2¼ to 2½ inches passes through the sizing chains F and is conveyed into bins M. The bulk of the crop, which is A grade, 2½ inches and larger, is distributed among the three bins N. After

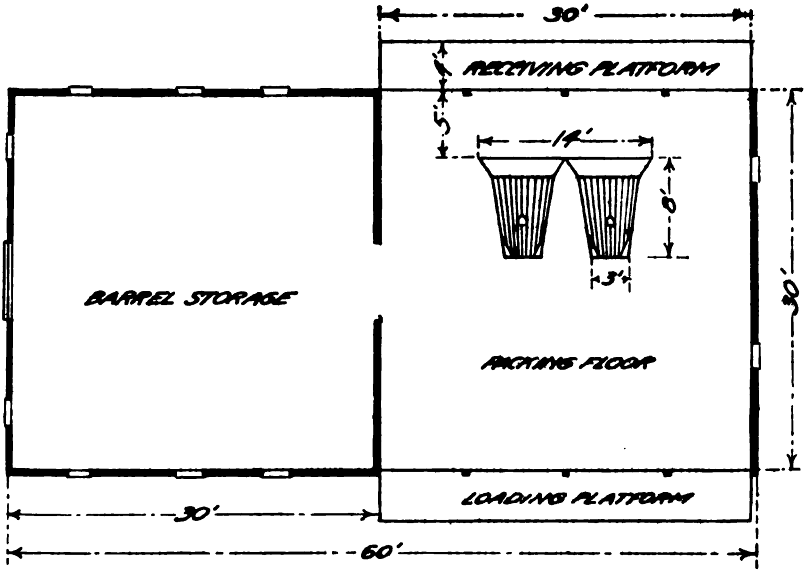

FIG. 11.—Plan 1: Floor plan of a packing house designed for handwork operations

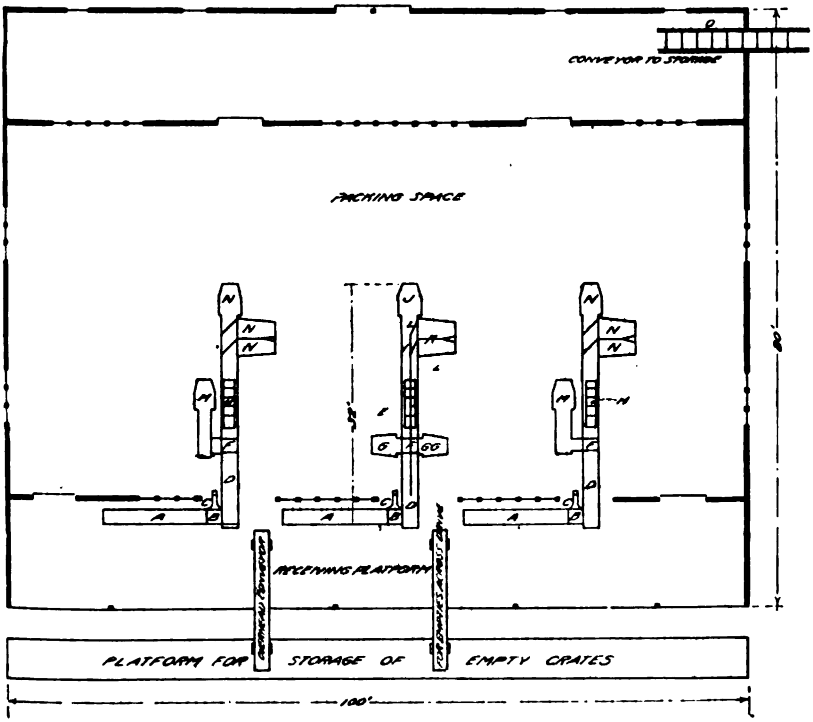

FIG. 12.—Plan 2: Floor plan of a community packing house with a capacity of 1,200 barrels a day

the barrels are headed they are passed to the platform in the rear of the house, and from there may be transferred by means of the conveyer O to storage or loaded on wagons and hauled to the cars. This house is equipped with two overhead conveyer belts for carrying empty crates across the drive from the main packing floor to the unloading platform. This arrangement keeps the whole area of the receiving platform always available for incoming fruit.

A loft should extend over the whole packing floor to serve as a barrel storage. The barrels may be coopered and stenciled here and lowered through shafts to convenient points on the packing floor. (See fig. 13.)

Plan 3 shows a house equipped with two machines having a total capacity of 1,000 barrels a day. (See fig. 14.) The fruit is delivered on a receiving platform which extends the total length of the house. The fruit is emptied from the orchard containers onto the conveyer belt A at any point along the platform. These conveyer belts are built 8 inches above the receiving platform, which greatly facilitates the emptying of the crates. The receiving platform B is built 48 inches above the level of the packing floor. The sorters work on the platform C, which is elevated 18 inches. The sizing belts are 56 inches above the packing floor, which makes it possible to deliver the fruit directly from the sizing chains into the packing bins by gravity. As the fruit passes over the first sizing rings at D all the apples under the minimum size for packing drop into a chute which delivers them into a cull pile outside the building. Sorters standing at the positions marked X remove the remaining culls and the B grade. The B grade is placed in baskets and emptied into bin F, which also contains the 2¼ to 2½ inch fruit. The remainder of the fruit is distributed to bins G, H, and I, which receive the sizes 2½ to 2¾ inches, 2¾ to 3 inches, and 3 inches and larger, respectively.

Apples of the various sizes which are selected for facing are carried to facing bins J. The full barrels are removed to the presses for heading. The barrel storage should be located in a loft over the packing floor where the barrels are coopered, stenciled, and placed in racks L, from which they are removed by the persons doing the facing. Packed barrels awaiting shipment may be stored temporarily on the covered platform M.

In plan 4 an arrangement is suggested which embodies many of the features desired in a conveniently arranged packing house. (See fig. 15.) The over-all dimensions of the house are 40 by 50 feet, with a total capacity of approximately 500 barrels per day. These dimensions can be changed in case it is desirable to provide a larger space for the storage of unpacked and packed fruit. The actual floor space occupied by the packing machinery is 20 by 30 feet. A large loft over the packing floor is used for the storage of empty barrels. Barrels are coopered in the loft and as needed are let down through the shafts A. This arrangement does away with an accumulation of empty barrels on the floor of the packing house which interferes with the operations of the crew.

The fruit-receiving floor is built 30 inches above the rest of the floor. The receiving space is enlarged by the addition of a 4-foot outside platform extending the width of the house. The feed belt B, 18 feet long and 2 feet wide, is raised 18 inches above the receiving

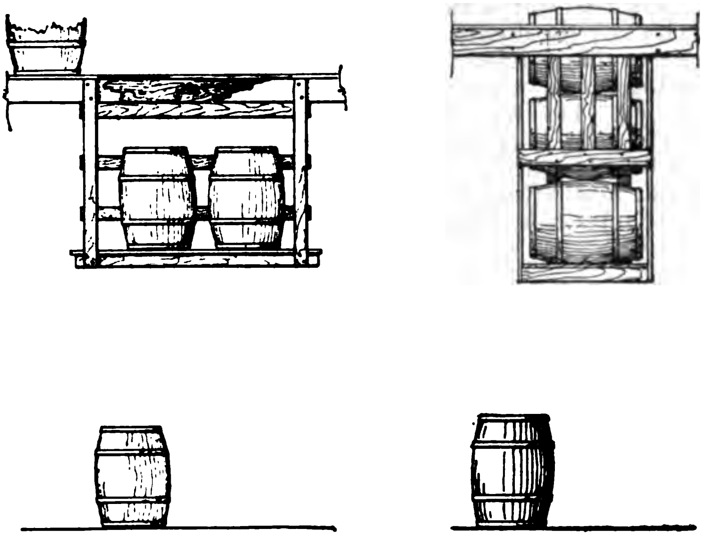

Fig. 13.—Two desirable methods of lowering empty barrels from loft to packing floor

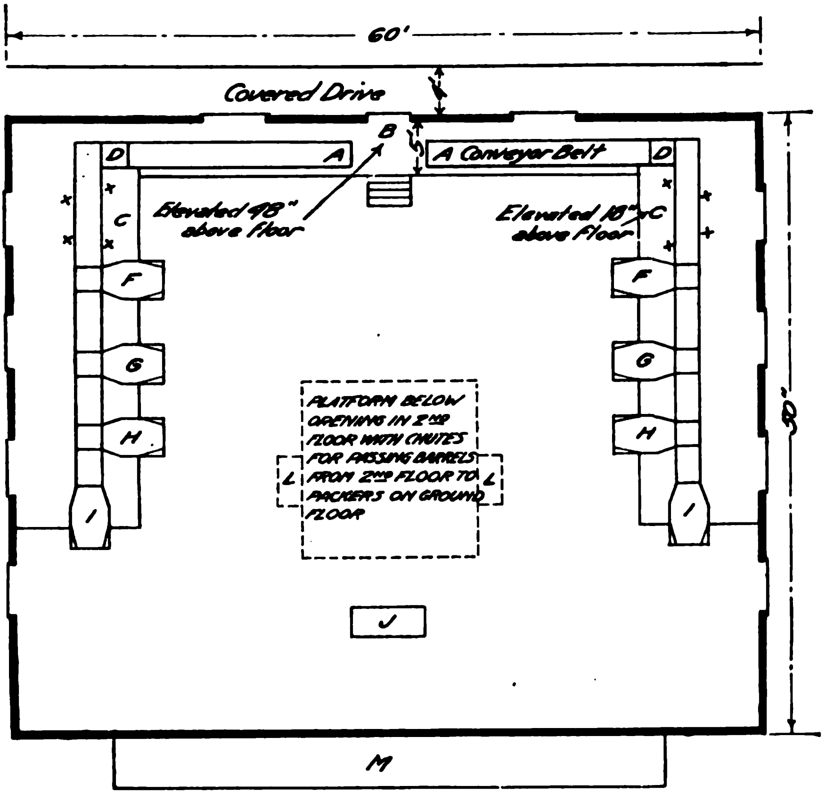
60'
Covered Drive
B
D
A
A Conveyor Belt
D
C
Elevated 48" above floor
Elevated 18" above Floor
C
F
F
G
G
H
H
I
I
PLATFORM BELOW OPENING IN 2ND FLOOR WITH CHUTES FOR PASSING BARRELS FROM 2ND FLOOR TO PACKERS ON GROUND FLOOR
L
L
J
50'
M

Fig. 14.—Plan 3: Floor plan of a well-arranged house capable of handling 1,000 barrels daily

floor. The feed belt of an ordinary grading machine is approximately $3\frac{1}{2}$ feet above the floor, and it is impracticable to empty barrels on a machine at this height. The fruit passes from the feed belt to the first sizing rings, where the cull fruit, smaller than $2\frac{1}{4}$ inches, is graded out. The fruit of larger size passes to a grading belt C, which is 7 feet long and accommodates six sorters. This belt is divided by a partition, so that as the fruit passes the B grade is sorted out and diverted into the first bin. The culls are thrown into two chutes E leading to the bin outside the house. The A grade fruit passes to the next sizing rings, where the fruit $2\frac{1}{4}$ to $2\frac{1}{2}$ inches in diameter is dropped into bin F. The remainder of the fruit is separated according to size into bins G, H, and I. Sorters stand on a raised platform 18 inches above the floor level. The sizing belts are 48 inches above the floor, and this height is sufficient to provide the proper drop to the packing bin. The fruit is loaded on the cars from a covered platform 6 feet wide and 80 feet long.

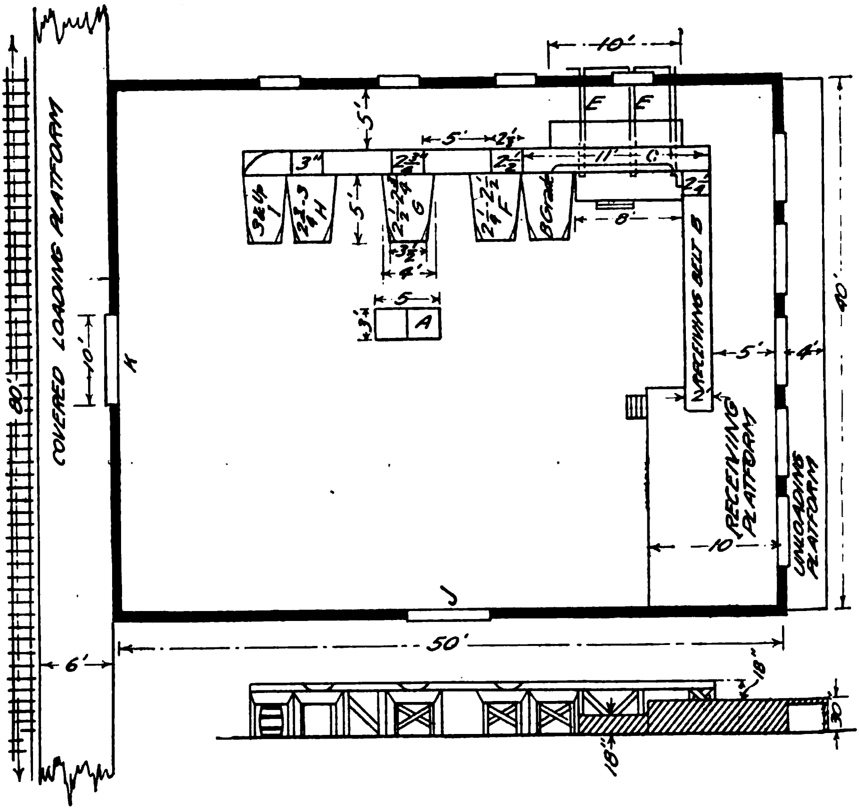

FIG. 15.—Plan 4: Floor plan of model house fully equipped for barrel packing

At the receiving end of the house there are doors hinged at the top to swing outward and upward. When open these doors form a cover to the platform and have the advantage of leaving the receiving floor free from obstruction. There are also sliding doors at J on the side of the house and at K in the rear. Windows are provided on the sides of the house, which, together with the doors, furnish abundant light for the packing operations.

HAULING

As a large part of the barreled apple crop is packed at the orchard, it is usually necessary to haul the packed fruit from 2 to 15 miles to the shipping point. It is important that this be done as rapidly and cheaply as possible and with a minimum amount of damage from shaking the pack and bruising the fruit.

Under many conditions, especially where good roads are available, motor trucks are best suited for such hauling on account of the combination of desirable features—speed, large capacity, and smooth carriage. Large trucks may be easily fitted with racks which make it possible to haul 35 to 40 barrels at a load. Tractors are used to some extent for hauling two or more wagons hitched together. The time gained in hauling the fruit by trucks or tractors is important in expediting the movement of the crop into proper storage and reduces the amount of labor necessary.

The farm wagon customarily used is equipped either with an ordinary wagon bed or a three-pole frame and has a capacity of about 15 barrels. The box bed is less desirable than the three-pole frame, because the barrels must be hauled on end, which subjects the pack to a much more severe strain than when the barrels are loaded on the side. With the three-pole wagon frame the barrels are loaded on the side and the poles are springy enough to give a certain amount of buoyancy to the load. Both types of wagons should be equipped with springs, preferably with bolster springs, which can be attached conveniently to any ordinary farm wagon. The importance of springs can not be too strongly emphasized, for careful handling of the packed fruit is as important as care in any of the packing operations. A rough, jolting haul frequently impairs the rigidity of the package to such an extent that it will not withstand the strain to which it is subjected in transit.

LOADING IN CARS

A good system of loading must provide for the even distribution of the strain on the barrels, which must also be stacked tightly enough to avoid shifting and breaking. The barrels should be arranged in such a manner that adequate ventilation will be provided. The most popular and probably the most satisfactory method of loading is known as the alternating-straight load (fig. 16). This load is started by placing two rows of three barrels each, end to end, across the car, which leaves a space of about half the length of a barrel at the end of the rows. The second layer is then started by placing a row of three barrels on top of the first two rows, but starting from the opposite side of the car and covering the open space between the ends of the rows below and the side of the car.

The remainder of the car is loaded in the same way, alternate layers being started from opposite sides of the car. This forms long channels along the walls lengthwise of the car which serve as flues for the circulation of air. When cars are shipped under refrigeration a load stacked in this way cools quickly, or if a ventilated car is used there is a free circulation of air throughout the car. An additional advantage is derived from this method because the bilge of one barrel does not rest directly upon the bilge of another, but rests in the hollow space over the ends of four barrels below.

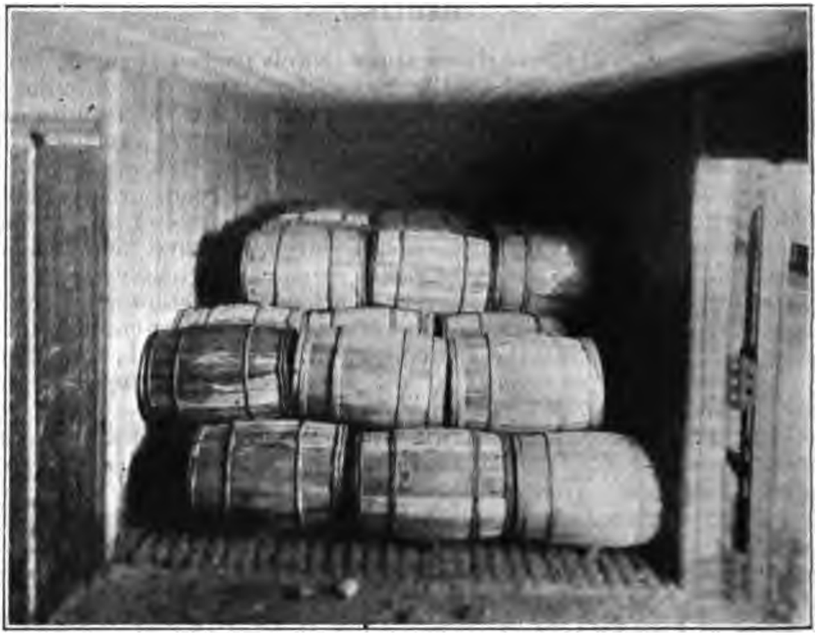

FIG. 16.—The alternating-straight method of loading

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September 12, 1925

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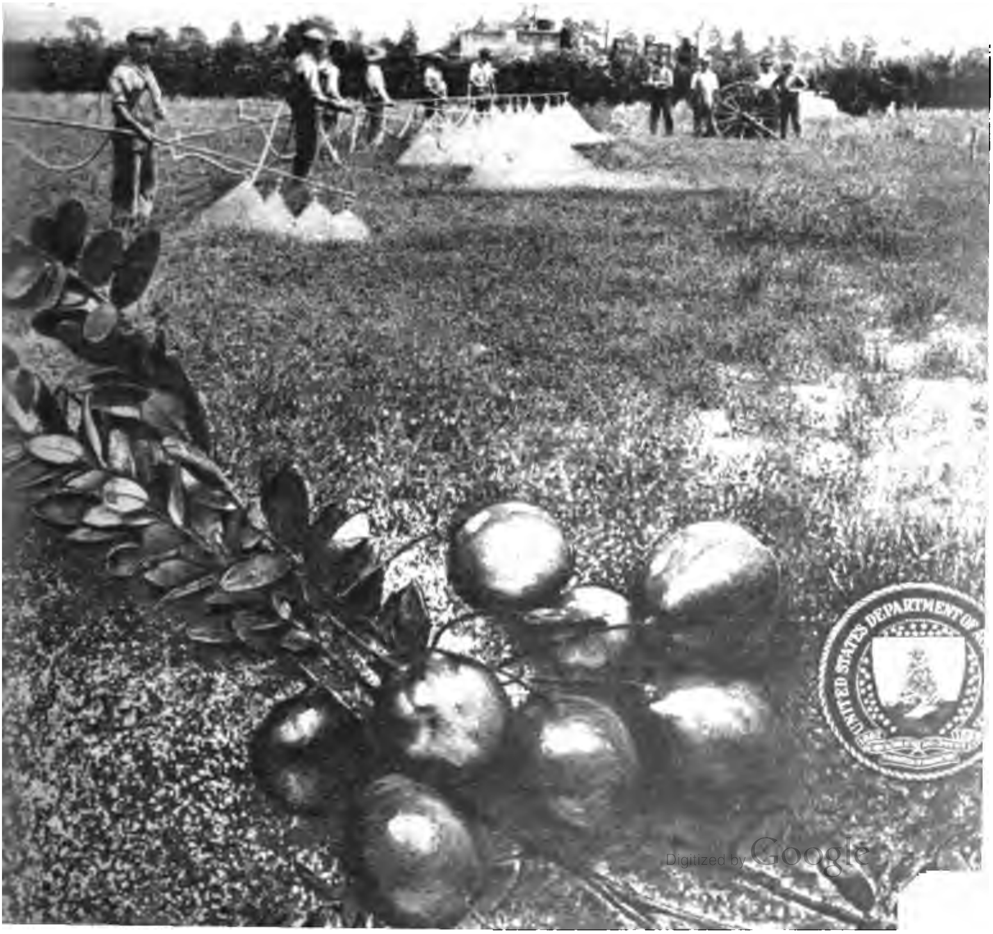
CRANBERRY DISEASES AND THEIR CONTROL



CRANBERRY DISEASES cause large losses each year. They are due to fungi and abnormal conditions of growth and treatment.

The principal fungous diseases can be prevented largely by spraying with Bordeaux mixture.

The large losses due to smothering can be avoided by proper methods and conditions of picking, storing, and handling the fruit.

Berries should be picked dry or dried quickly, handled carefully, kept in a cool well-ventilated place, and packed preferably in bushel or half-barrel boxes.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. December, 1920

CRANBERRY DISEASES AND THEIR CONTROL.

C. L. SHEAR,
Pathologist, Fruit-Disease Investigations, Bureau of Plant Industry.

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DEVELOPMENT OF CRANBERRY DISEASES.

THE AMERICAN CRANBERRY[1] has been in cultivation in this country for nearly a century. Some of the present cranberry meadows have been bearing fruit for 50 years or more. This long-continued growth of the same crop on the same land under the same conditions has favored the development and spread of certain diseases, some of which at present are unknown or rarely found on wild cranberries. These diseases are gradually spreading and becoming more serious.

Wild cranberry plants under natural conditions do not appear to be seriously affected by disease. As is generally the case, however, when a plant is subjected to cultivation and changed conditions and planted over extensive areas, the opportunities for the development and distribution of parasites increase and its diseases become more serious. At the same time the plants under cultivation appear in some cases to become weakened and more susceptible to disease.

The American wild cranberry occurs from Newfoundland southward along the coast and through the Alleghenies to North Carolina and westward along the Great Lakes to Wisconsin and Minnesota. The commercial production of this fruit is at present restricted to a few States, the bulk of the crop being grown in Massachusetts, New Jersey, Wisconsin, Oregon, and Washington.

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[1] *Vaccinium macrocarpum.*

The cranberry plant differs greatly from most cultivated plants in its food and water requirements and also in its method of obtaining certain portions of its food. In common with most of the plants of the heath family, it requires an acid soil and obtains part of its nutriment through the aid of a beneficial fungus, known as mycorhiza, which lives in the rootlets. There is much yet to be learned in regard to the best conditions and methods necessary for the production of the most vigorous and healthy cranberry plants. A plant, like an animal, when lacking proper and sufficient food or water becomes weakened and more susceptible to disease than one that is properly nurtured and hardy.

Every cranberry bog differs from every other, and in many cases different parts of the same bog differ in the origin and composition of the soil and in the character and distribution of the soil water and plant food. Experience, careful observation, and study must determine the most satisfactory methods of handling a particular bog in order to obtain the most vigorous, healthy, and productive vines.

SANITARY CONDITIONS.

Much can be done to prevent the development and spread of fungous diseases and increase the vigor and resistance of the vines by carefully regulating the water supply of the bog during the growing season.

Many growers keep the bogs too wet, especially on rich peat bottoms. This tends to produce an excessive growth of vines and favors the fungous diseases. Regular and judicious pruning should be practiced wherever the growth of vines is heavy. The prunings, unless used for planting, should be destroyed by fire in order to prevent the spread of the fungi which soon develop on them and furnish a source of infection for the bog. Rotten fruit discarded in sorting and screening should be buried or otherwise disposed of, so as to prevent the spread of disease.

RESISTANT VARIETIES.

Certain varieties of berries are more susceptible to disease than others. Therefore, in making a new planting varieties which have been found to be most healthy in the locality should be selected where practicable.

Little attention has yet been given to the selection and breeding of resistant varieties. In general, the smaller, firmer fruited varieties are less subject to rot than those bearing larger berries.

The average annual cranberry crop of the United States is about 500,000 barrels, valued at $3,000,000. The total loss from disease is estimated to average at least 25 per cent, or $750,000 a year. Of this loss about 10 per cent occurs before the fruit is picked and 15 per cent after picking. The losses seem to be greater in the southern localities. The longer summers and higher average temperatures in the South are apparently less favorable to the production of hardy cranberry plants, while they seem more favorable to the development of certain serious fungous parasites.

DISEASES DISCUSSED.

The following diseases will be discussed here. They are arranged in the order of their destructiveness, the worst being presented first. Several others are known, but they are regarded as of no great economic importance at present.

- Early-rot (scald, blast, dead-spot, leaf-spot).
- Bitter-rot (anthracnose).
- End-rot (blossom end-rot, stem end-rot).
- Blotch-rot (rot).
- Hard-rot.
- Tip-blight.
- Red-gall.
- Rose-bloom (Massachusetts false-blossom, hypertrophy).
- Red leaf-spot.
- False-blossom (Wisconsin false-blossom, phyllody).
- Black-rot.
- Rust.

EARLY-ROT.

The name early-rot is applied to the disease caused by a fungus[1] closely related to that producing black-rot of the grape. The different stages and forms of reproduction of this parasite are shown in figure 1. The fungus attacks all of the aerial portions of the plant.

The most serious injury is usually caused by the destruction of the fruit, which may be attacked at any time during its development. Under favorable conditions for the growth and distribution of the fungus it attacks the flowers and very young fruits, causing the latter to shrivel and become blackened and finally covered with the spore-bearing pustules of the parasite. This form of the disease has sometimes been called blast and sometimes blight. Blossoms and young fruit frequently fail to develop from other causes, such as imperfect fertilization of the flowers, or from unfavorable weather conditions, such as excessive heat or cold or excessive moisture or drought, or from insects or fungous diseases. Wherever the injury is due to early-rot it is followed by the development of the minute black fruiting bodies of the fungus on the blackened and more or less shriveled young fruit of the cranberry.

The fruit attacked by this disease when half grown or more shows at first a minute light-colored soft spot on the surface. This spot spreads in a concentric manner until finally the whole berry becomes soft and sometimes marked by more or less distinct dark-colored rings. If the rot develops rapidly, however, the berry may show little discoloration. Occasionally the rot is restricted to a small area on the fruit and the tissues become sunken, and sometimes the minute black spore-bearing bodies of the parasite develop. Ordinarily, however, there is no indication on the surface of the fruit of the presence of the parasite except the occasional dark spots or brownish zones.

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[1] *Guignardia vaccinii* Shear.

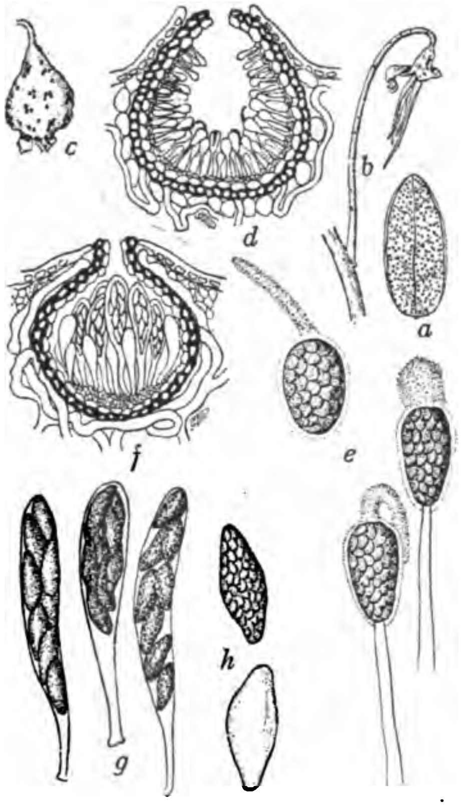

FIG. 1.—The early-rot fungus: *a*, *b*, and *c*, Fruiting bodies on leaf, stem, and fruit (natural size); *d* and *e*, pycnidium and spores; *f*, *g*, and *h*, perithecium and ascospores (much magnified).

Berries attacked before they are three-fourths grown frequently shrivel or become mummied and blackened and covered with the fruiting bodies of the fungus. This condition is more frequent in New Jersey than in more northern localities, where the disease does not usually make its appearance until the fruit is nearly half grown.

The disease as it affects the nearly grown fruit was formerly called scald, especially in New Jersey. This name had its origin in the belief previously held by many growers that the softening of the fruit caused by the fungus was due to the action of the hot sunshine upon the berries when wet with dew or rain. Occasionally a real scalding occurs on berries which have been overflowed and covered with water for half a day or more during hot weather. Injury of this kind, however, is infrequent and can be distinguished from that caused by fungi by the difference in effect upon the tissues of the fruit. In the case of fungous injury the tissues beneath the skin are mostly destroyed, but the berries remain turgid and elastic under slight pressure. In the case of sun scald, the tissues beneath the light-colored spot are more or less collapsed, or shrunken, or withered, and the spot does not increase in size, as in the case of early-rot.

Occasionally this fungus also attacks the foliage of the plant, causing an irregular reddish brown spot, which may show spore-bearing pustules (pycnidia or perithecia) of the fungus. Usually, however, where the fungus invades the whole leaf it produces no spot, but causes the leaf to drop prematurely. The fruiting pustules of the fungus develop chiefly on the leaves after they have fallen. If cuttings from bogs affected with this disease are planted, the young growth is frequently defoliated by this fungus and sometimes is so seriously injured that the plants die. In old plantings the disease, when very severe, sometimes causes the death of the plants in spots. These are sometimes called dead spots and also, incorrectly, ringworm. The latter name should not be used in connection with fungous diseases, as there is an insect which produces similar dead spots. Where the vines are killed there is no evidence to be found of any injury to the root system by insects or other agencies and the dead foliage of the plants is covered with the fruiting pustules of the early-rot fungus. Sometimes other fungi are also associated with this, tending to increase the injury.

Early-rot is found in all the cranberry-growing sections of the country and is widely distributed on the native wild cranberry plants. It is most prevalent and produces most injury in the southern areas of cranberry cultivation. In the northern areas it appears later in the season and sometimes does not develop until after the fruit has been harvested. Much loss from this disease is caused as a result of dormant infections, which develop and destroy the berries during the period of sorting, packing, shipping, and marketing.

CONTROL.

Experiments conducted by the United States Department of Agriculture and also the experience of various growers during the last 10 years have demonstrated that this disease can be satisfactorily prevented by thorough spraying with 3–3–50 soap-Bordeaux mixture. This mixture should be prepared as follows:

Copper sulphate (blue vitrol or bluestone)	pounds	3
Fresh stone lime	do	3
Water	gallons	50
Commercial resin-fishoil soap	pounds	1

The soap should be dissolved in about 10 gallons of water and added after the lime and bluestone have been mixed. The two requisites for the production of good Bordeaux mixture are fresh stone lime and the thorough mixing of the lime and bluestone solutions. The soap has been found necessary in order to cause the mixture to spread and adhere to the glossy surface of the cranberry fruit and foliage. Where early-rot is serious, at least four applications of Bordeaux mixture should be made during the season, using 150 to 200 gallons to the acre. The first application should be made just before the flowers begin to open, the second when the blossoms begin to fall, the third two weeks later, and in severe cases a fourth not later than August 15, as later applications are likely to produce a staining of the fruit which may not be washed off before picking.

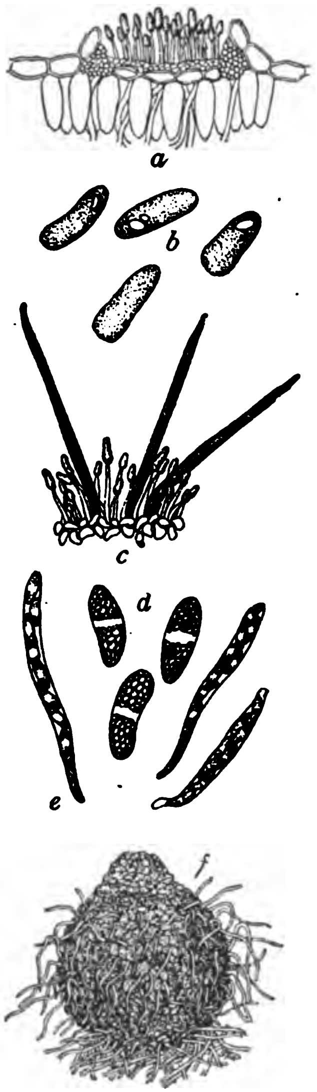

FIG. 2.—The bitter-rot fungus: *a*, *b*, and *c*, Conidial fructifications; *d*, *e*, and *f*, perithecium and ascospores. (All much magnified.)

BITTER-ROT[1] (ANTHRACNOSE).

This disease is very similar to the bitter-rot of apples and other fruits. The different spore forms and the fructifications of the fungus are shown in figure 2. This fungus attacks both the foliage and the fruit, causing most injury, however, to the fruit. The appearance of bitter-rot on the fruit is not easy to distinguish from several other rots which attack cranberries, and unless the fungus happens to be fruiting on the berries it is usually impossible to determine positively the cause of the rot without making cultures from the tissues of the affected berries or making a careful microscopic examination of the fungus in the interior of the fruit. Affected berries become softened and show more or less of a brownish yellow discoloration.

Bitter-rot is widely distributed and has been found in New Jersey, New York, Massachusetts, Wisconsin, Washington, and Oregon. Its seriousness in any particular locality appears to be closely associated with the weather conditions. Hot weather during July and August appears to be most favorable for its development. The disease usually develops rather late in the season, and frequently not until after the fruit has been harvested.

---

[1] Caused by *Glomerella cingulata vaccinii* Shear.

CONTROL.

Bitter-rot is somewhat more difficult to control than early-rot. The treatment should be the same as for early-rot, using Bordeaux mixture as recommended and making four applications. Special effort should be made to get the mixture on the vines before a rain. If this can not be done, it should be applied immediately afterwards.

END-ROT[1] (BLOSSOM END-ROT AND STEM END-ROT).

End-rot is a fungous rot of cranberries which has been distinguished from the other rots only within the last few years. It has been found, however, in all the cranberry-growing districts of the United States and has been the cause of considerable loss recently in Massachusetts and Wisconsin. It is called end-rot because, so far as known at present, it always starts at either the blossom or stem end of the berry. Most of the other rots usually start at some other point on the fruit. Aside from the fact that this rot usually begins at the end of the berry, it has no characteristic which makes it distinguishable from some of the other cranberry rots. The fruit when attacked becomes softened and the skin light colored or yellowish. The trouble develops late in the season, especially after picking and packing, and is most common in the northern sections.

CONTROL.

Experiments conducted during the last few years in cooperation with the Massachusetts Cranberry Experiment Station at East Wareham, Mass., have shown that end-rot is reduced by spraying with Bordeaux mixture, as recommended in the regular treatment for early-rot.

BLOTCH-ROT[2] (ROT).

As in the case of some of the other fungous rots of the cranberry, the appearance of the fruit attacked by blotch-rot is not sufficiently distinct for the grower to distinguish it from some of the other rots. The disease is due to the fungus which is shown in the accompanying illustration (fig. 3). This rot first appears as a small, light-colored, soft spot on the berry, finally spreading and destroying the whole fruit. In the later stages of its development it very frequently, though not always, produces small dark-colored blotches in the skin of the fruit. This appearance has suggested the proposed common name, blotch-rot. The only way in which this disease can be positively determined, however, is by making artificial cultures of the fungus from the diseased berries, a method only available to the plant pathologist. This fungus also attacks the leaves, but it is very rarely found fruiting on them until after they have fallen to the ground.

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[1] Caused by *Fusicoccum putrefaciens* Shear.

[2] Caused by *Acanthorynchus vaccinii* Shear.

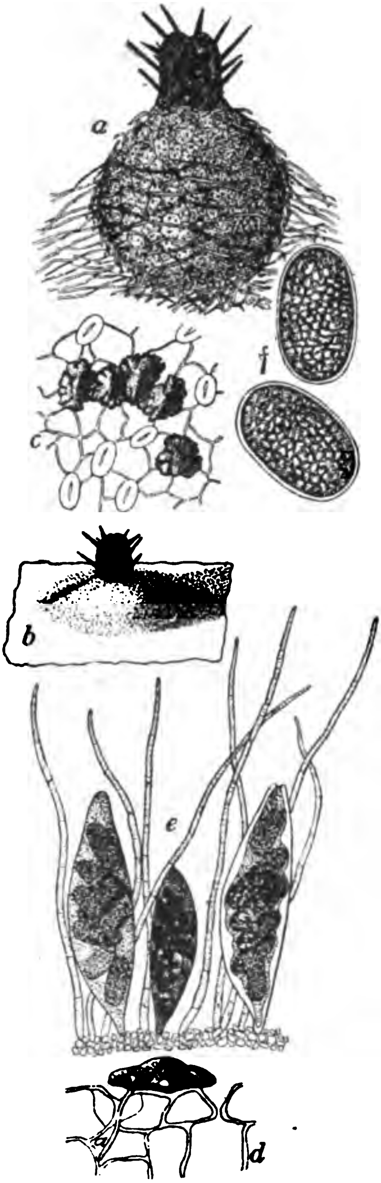

Fig. 3.—The blotch-rot fungus: *a* and *b*, Fruiting bodies; *c* and *d*, organs of attachment; *e* and *f*, asci and spores. (All much magnified.)

Blotch-rot has been found throughout the cranberry-growing sections of the United States and also Nova Scotia. Just how much of the annual loss from rot is due to this disease it is impossible to say, on account of the difficulty of distinguishing it from other diseases. The fungus occurs so frequently, however, in cultures from diseased berries that it is probably one of the common causes of rot.

CONTROL.

Spraying with Bordeaux mixture, as recommended for early-rot, is a satisfactory preventive of this disease.

HARD-ROT AND TIP-BLIGHT.[1]

Hard-rot and tip-blight are forms of a fungous disease caused by an organism closely related to the brown-rot fungus which attacks peaches and other fruits. The first appearance of this disease is to be found on the young growing tips of the plants just before blossoming. The affected tips wilt and dry up, and the gray or white conidia of the fungus develop on them. This is the tip-blight form of the disease.

Later in the season the fungus attacks the fruit, apparently gaining entrance through the blossoms and producing what is termed "hard-rot." The appearance and character of the fruit affected with this disease are well marked and easily recognized when once seen. The affected berries instead of coloring up naturally as they approach maturity become a more or less sordid, pale, yellowish white color, and instead of becoming softened, as in the case of most other fungous diseases, the tissues remain rather firm and leathery. Upon cutting an affected berry through the center the seed cavities will be found to contain a white fungous growth having a cottony appearance. Later in the season such berries shrivel, become darker and harder, and finally become mummied. These mummies contain the sclerotia or resting form of the fungus, which lives over winter. The mature or ascus-bearing form of the fungus has not yet been found on the cranberry, but should be produced from these mummies during the following spring or early summer.

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[1] Caused by *Sclerotinia oxycocci* Wor.

Hard-rot and tip-blight thus far have been found only in Wisconsin and on the Pacific coast. Fortunately, the disease has not yet been very serious. If it should become general it has possibilities of causing much loss, as the affected tips die and bear no fruit and the affected berries are worthless.

CONTROL.

The uncertainty of the occurrence of hard-rot and its scattered appearance have prevented the careful testing of fungicides. From our knowledge of diseases caused by closely related fungi, such as the brown-rot of peaches, plums, etc., there is reason to believe that this disease can be prevented by spraying with Bordeaux mixture. The first application, however, should be made as soon as the new growth starts, in order to prevent the infection of the tips. Further applications should be made as for early-rot.

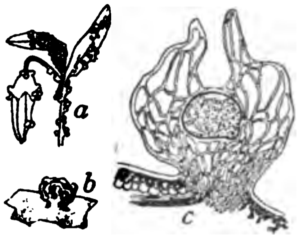

FIG. 4.—The red-gall fungus, showing (*a*) leaves and flower bud affected with galls (natural size), (*b*) enlarged single gall, (*c*) section through a single gall (much magnified), showing the fungus in a circular mass in the center.

RED-GALL.[1]

The red-gall of cranberries is a disease which once seen is very easily recognized. The galls are caused by the fungus shown in figure 4. The disease usually appears just before the blossoms open. The buds, young leaves, and shoots become more or less covered with small, red, somewhat irregular globular galls about the size of bird shot. The affected shoots produce no fruit.

Red-gall is very erratic in its occurrence. The cases thus far observed have appeared on a large number of plants on certain bogs during a particular season and have frequently disappeared the next season. The distribution and development of the parasite seem to depend primarily upon the water conditions of the bog and the amount and distribution of the rainfall. The spores of the fungus are adapted to distribution by water. The affected bogs are usually those which have an excessive water supply or which are uneven and not properly drained. This disease has been found thus far only in eastern cranberry bogs and most frequently in New Jersey.

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[1] Caused by *Synchytrium vaccinii* Thomas.

CONTROL.

The proper grading of the bog and the control of the water supply seem to be the best methods of preventing red-gall. Its uncertain occurrence and the impossibility of ascertaining its presence until the young galls appear render it impracticable to employ spraying as a means of prevention. Bogs which are properly drained and from which the flood waters are removed early are rarely, if ever, seriously affected with this disease.

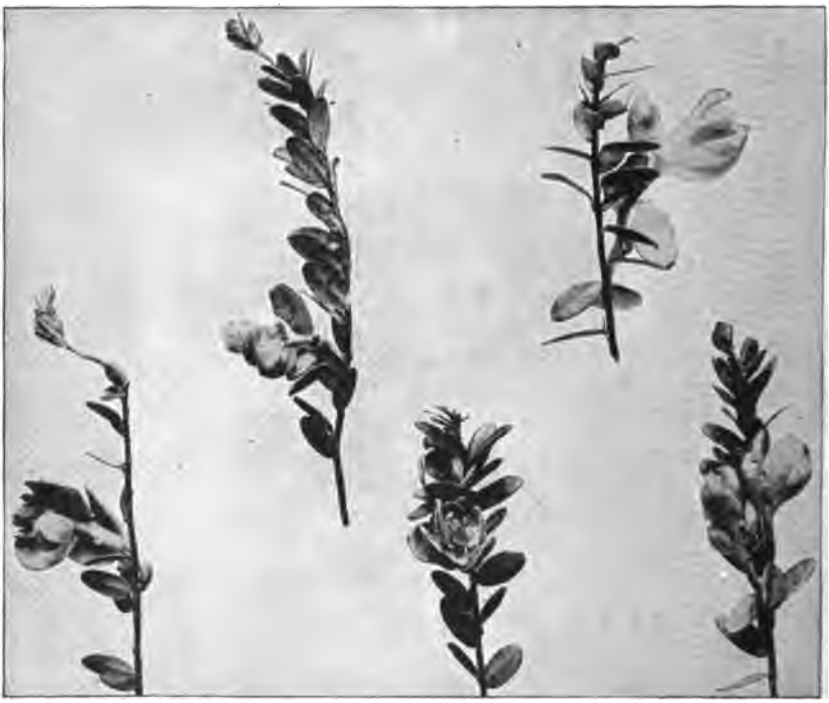

FIG. 5.—Cranberry rose-bloom, showing the abnormal, flowerlike, enlarged lateral shoots.

ROSE-BLOOM[1] (MASSACHUSETTS FALSE-BLOSSOM, HYPERTROPHY).

Rose-bloom was first observed in Massachusetts and has since been found in the States of Washington and Oregon. It does not appear to be widely distributed at present and has proved a serious cause of loss on only a few bogs. Like the red-gall it is rather erratic in its appearance, occurring in abundance one season and perhaps being of little importance on the same bog the next season. It has been found most serious on the Matthews variety in Massachusetts. The disease first makes its appearance on winter-flowed bogs soon after the water has been removed in the spring. The buds in the axils of the leaves of the fruiting shoots, which usually remain dormant, are attacked by the fungus, which stimulates growth, resulting in abnormal lateral shoots bearing enlarged, swollen pink or light rose-colored distorted leaves. The appearance of these shoots is shown in the accompanying illustration (fig. 5). These colored hypertrophied leaves being somewhat crowded together bear a slight superficial resemblance to a flower. This has led to the use of the common names, rose-bloom and false-blossom. The term "false-blossom," however, should be restricted to another disease, to be described later, to which it is more applicable. As this disease usually develops before the blossoms appear, the vitality of the shoot is exhausted and no fruit is produced. Vegetative shoots, or runners, are sometimes attacked also. In such cases, of course, the injury is of less importance. The occurrence of rose-bloom is usually associated with an excessive water supply, which seems to favor its development. Holding the winter flowage until late and reflowing tend to increase the disease when present.

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[1] Caused by *Exobasidium oxycocci* Rost.

CONTROL.

Early spraying with Bordeaux mixture appears to be helpful in controlling rose-bloom. When the disease is known to occur on a bog the water should be removed earlier in the spring than usual and reflowing avoided if practicable.

RED LEAF-SPOT.[1]

Red leaf-spot is caused by a fungus very closely related to the one producing rose-bloom; in fact, some investigators regard them as merely forms of the same species. The effect upon the plant, however, is quite different. The red leaf-spot, as shown in the accompanying illustration (fig. 6), produces a more or less circular spot upon the leaf and is usually bright red, especially on the upper side. On the lower side the spot is paler and covered with fine spore-bearing filaments of the fungus, giving the appearance of a dense bloom or powder.

This disease has been found in all cranberry-growing sections, but it does not usually cause serious injury to the plants except in

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[1] Caused by *Exobasidium vaccinii* (Fckl.) Wor.

Washington and Oregon, where the climatic conditions, especially damp weather, and the luxuriance of growth of the vines appear to furnish unusually favorable conditions for the development and spread of the fungus. That an excess of moisture in the form of fog, rain, or flood is the principal factor in making this a serious disease is indicated by the behavior of this fungus in Massachusetts in 1916. The greater part of that season was unusually wet, and red leaf-spot was much more common than usual. Though the fungi producing rose-bloom and red leaf-spot are so very closely related, the two diseases have been rarely found to occur together. Occasionally they may be found on the same bog, but rarely or never on the same plant.

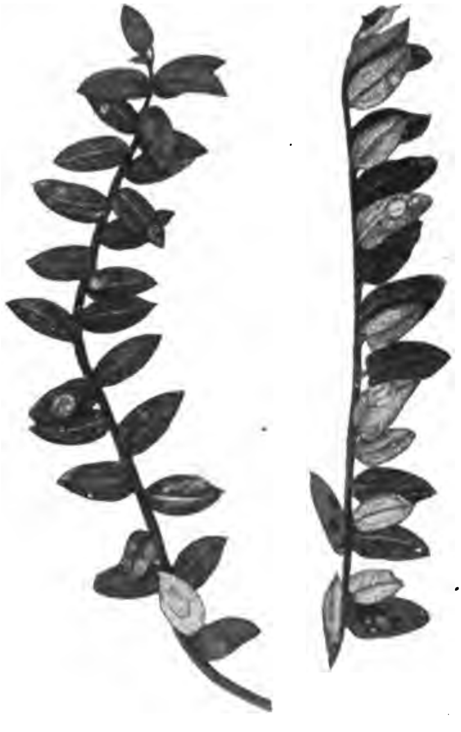

FIG. 6.—Red leaf-spot of the cranberry.

CONTROL.

Spraying with Bordeaux mixture, as for early-rot, appears to be effective in controlling red leaf-spot, according to the experience of some Pacific-coast growers.

FALSE-BLOSSOM (WISCONSIN FALSE-BLOSSOM, PHYLLODY).

The real cause of the disease known as false-blossom is at present unknown. Studies thus far have failed to show that it is due either to insects or to fungi. It is also uncertain whether it is of an infectious nature. Some observations seem to indicate that the trouble may be caused, in part at least, by unbalanced nutritive conditions. False-blossom has been found chiefly in Wisconsin. The cases which have been found in Massachusetts, New Jersey, Washington, and Oregon appear to have originated, in most instances at least, from plants obtained from Wisconsin.

The chief features of this disease are shown in the accompanying illustrations (figs. 7 and 8). In its simplest form the flower pedicels become more or less erect instead of drooping, the calyx lobes become enlarged and somewhat leaflike, and the petals are short and broad and slightly reddish or greenish in color. The stamens and pistils are more or less aborted and malformed, and affected plants produce little or no fruit. All intermediate forms and gradations can be found among diseased plants, from the simplest stage, in which there is only a shortening and thickening of the parts of the flower, to cases in which the entire flower is replaced by a short branch with small leaves, as shown in figure 8, *d* and *e*. Affected plants also show a marked tendency toward the development of abnormal terminal buds and of lateral branches arising from the usually latent axillary buds. Such branches are slender and weak and fail to produce normal flowers or fruit. They give the plant a kind of witches'-broom appearance, as shown in figure 7.

This trouble is usually associated with extreme wet or dry conditions of the bog, but most frequently with an excessive water supply. In most of the localities in which it has been observed the affected plants were growing in a deep, coarse peat soil having an excessive water supply during the greater part of the growing season.

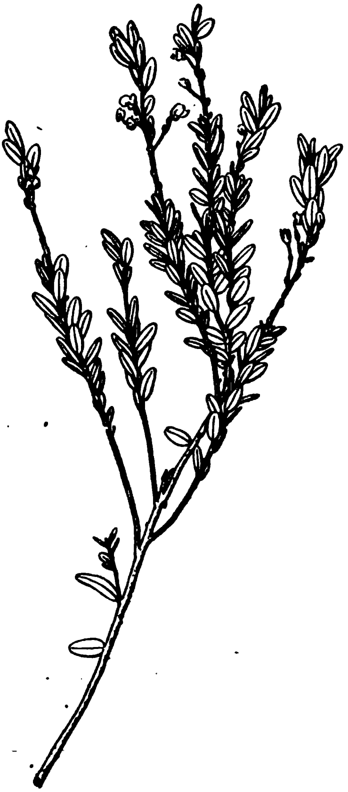

FIG. 7.—False-blossom of the cranberry, showing the witches'-broom form due to the abnormal development of axillary buds.

CONTROL.

In the absence of more definite knowledge of the exact cause of false-blossom it is impossible to recommend satisfactory methods of prevention and control. The best conditions possible for normal growth should be provided, especially good drainage, clean culture, and pruning. Where a large number of the plants in a bog are affected with false-blossom it would probably be best to remove and burn the diseased plants and to replant with healthy vines. To prevent the further introduction and spread of the disease only vines known to be absolutely free from false-blossom or coming from localities free from the disease should be used in planting.

BLACK-ROT.[1]

Black-rot develops chiefly in fruit after picking. The affected berries become very dark colored and softened. The fungus causing

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[1] Caused by *Ceuthospora lunata* Shear.

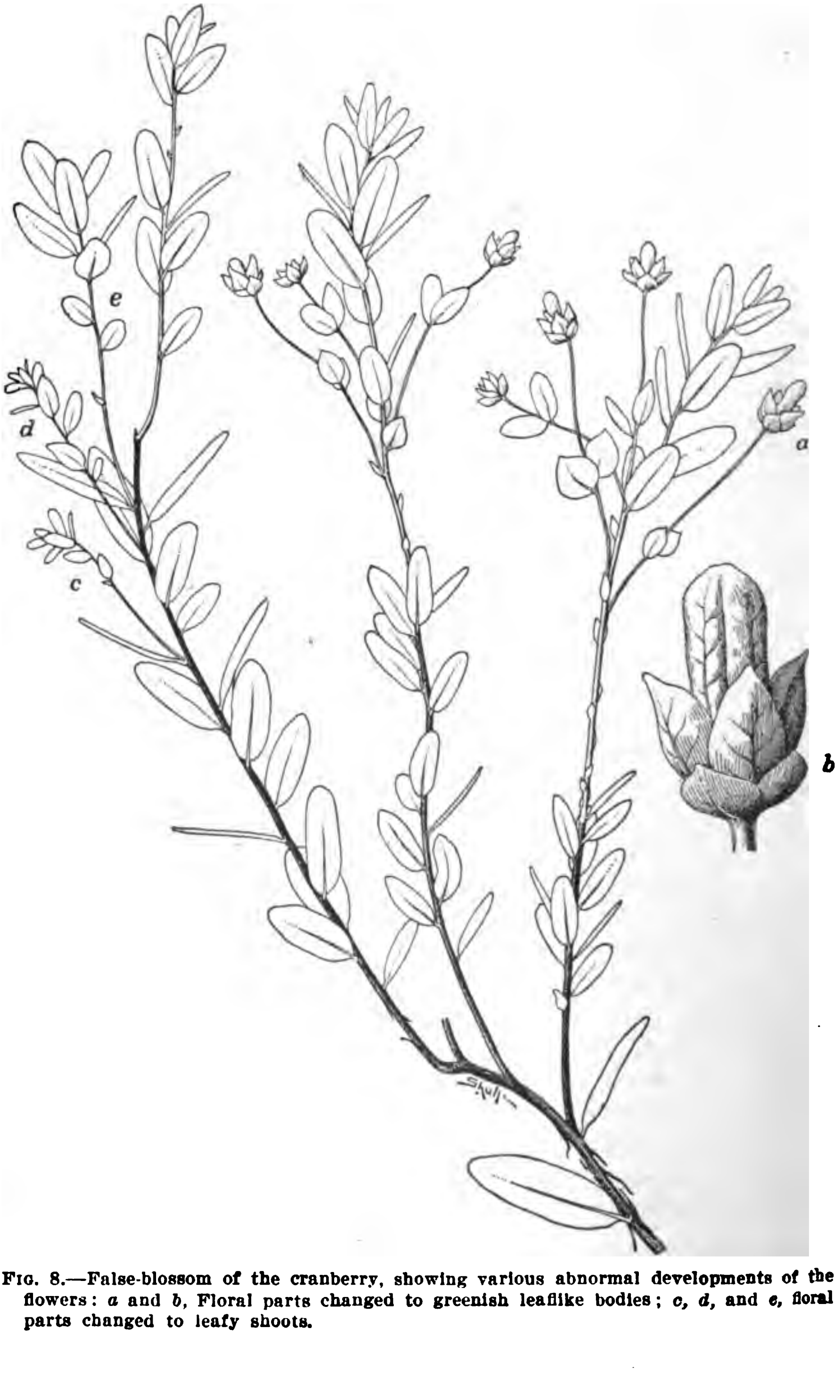

FIG. 8.—False-blossom of the cranberry, showing various abnormal developments of the flowers: *a* and *b*, Floral parts changed to greenish leaflike bodies; *c*, *d*, and *e*, floral parts changed to leafy shoots.

this disease has also been found on dead and dying leaves, but has not caused much injury. It has been found most frequently on fruit from Massachusetts and New Jersey.

CONTROL.

Bogs which have been thoroughly sprayed usually show little of this trouble, and its development can be largely prevented by proper conditions of storage and handling of fruit, as mentioned on page 18.

RUST.[1]

This disease has thus far been observed only in the cranberry bogs on the Pacific coast and has caused no serious injury; but if it should develop in an epidemic form, as is possible, it might do considerable harm to cranberries. It is caused by one of the rust fungi, which forms minute yellowish powdery pustules on the under side of the leaves.

The early spore stage of this fungus develops on hemlocks, and on the Pacific coast will probably be found upon the western hemlock. The disease is likely to occur, therefore, in the East or the West, wherever hemlock is found near cranberry bogs.

CONTROL.

If the rust should prove sufficiently serious to justify the expense, it could probably be controlled by the removal of the hemlocks in the vicinity of the cranberry bogs, if this should seem practicable.

ROT AND SPOILAGE DURING STORAGE, SHIPPING, AND MARKETING.

Until recently the losses from fungous diseases which occur after the crop is harvested have been more or less overlooked and neglected. In the case of the cranberry, the losses after picking are frequently much more serious than those occurring before harvest. These losses are due chiefly to two causes: Fungous parasites which have infected the fruit before picking but have remained in a dormant condition and the smothering or killing of the fruit by lack of ventilation.

By observation and investigation it has been found that about one-half of the loss of berries after picking is due to fungi. The most frequent and important of these fungous rots in recent years have been the early-rot and the end-rot. The development of these rots after picking depends largely upon the conditions under which the fruit is kept and the methods of handling. Where experience has shown that serious losses occur after picking, spraying should be practiced, as recommended for the control of these rots, as this will prevent largely the infection of the fruit which occurs before picking and thus greatly reduce the losses which develop after picking.

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[1] Caused by *Pucciniastrum myrtilli* (Schum.) Arth.

The fruit should be picked dry or dried very quickly after picking, as cranberries which are stored when wet rot more quickly than dry fruit. Great care should be used in handling the fruit. Even slight bruises greatly increase the amount of rot. The berries should be run through the separator only once. In sorting or screening, squeezing the berries should be avoided, and in running berries into barrels or boxes some sort of easer should be used to break the fall and prevent bruising.

The temperature under which the fruit is kept is a very important factor in determining its keeping quality. High temperatures greatly favor the development of fungous rots. As the fruit is usually warm when picked it should be placed in the shade and cooled as rapidly as possible. The storehouse should be well ventilated at night and closed as far as possible during the day, when the outside temperature is usually higher than that inside. In sorting or screening the fruit in cold weather the berries should be kept in a warm room as short a time as possible and packed in a cool room.

SMOTHERING.

Besides the fungous rots, a large amount of spoilage of stored fruit is due to the premature death of the berries and the physical and chemical changes which follow. Such fruit becomes somewhat softened throughout, discolored, and practically worthless. Upon cutting open such berries it will be found that the interior is red and juicy and its natural flavor gone. The cranberry, when picked, is a living organism, carrying on active life processes which are continued under ordinary conditions for a considerable time after the fruit has been removed from the vines. In order to keep the fruit it is necessary to prolong as far as possible these life processes and prevent death. The cranberry may be said to breathe in its own peculiar way, and when it is prevented from so doing it suffocates and dies. The more rapid this breathing the more quickly is the fruit spoiled.

In general, it has been found that high temperatures hasten the death of the fruit by smothering. High temperatures and lack of ventilation are the chief causes of smothering. In order to reduce such loss to a minimum the fruit should be cooled as quickly as possible after picking, being set in a shady well-ventilated place either under trees or under a simple roof of boards or canvas. The berries should never be covered tightly by spreading canvas or oilcloth over piles of boxes unless the weather is cold.

As much as possible of the hauling to the storehouse should be done early in the day, and the house should be so arranged as to cool the fruit quickly and keep it cool. Ventilating should be done at night and the storehouse kept closed as much as possible during the day. In packing cranberries for market ventilated containers are preferable, especially during warm weather. Half-barrel or bushel ventilated boxes have been found more satisfactory than barrels in reducing the losses from rot and smothering during shipping and marketing.

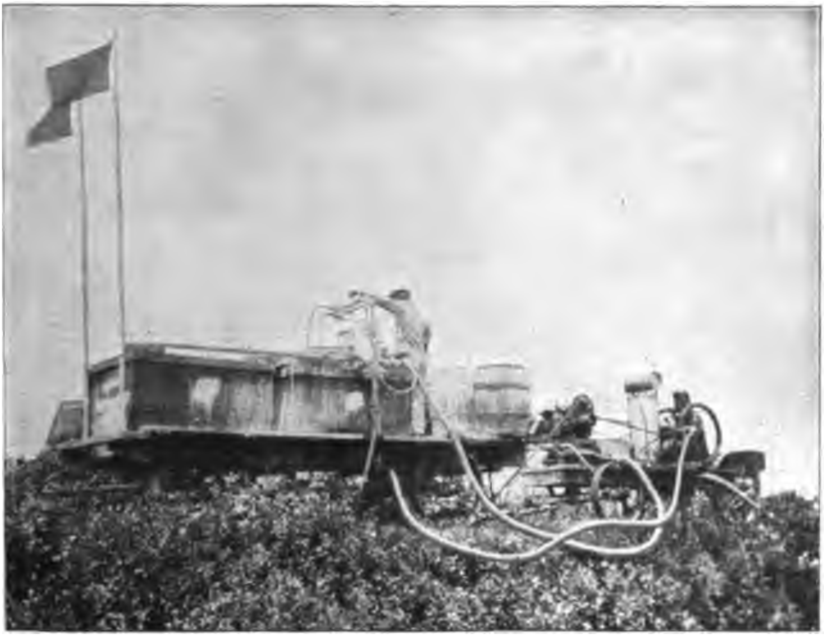

FIG. 9.—A gasoline-engine spraying outfit on two trucks.

SPRAYING.

The conditions under which cranberries are grown and the character of the plants are so different from those which obtain with other fruits that special methods have been found necessary for the most economic and effective application of fungicides and insecticides.

On the small areas sometimes found in Massachusetts knapsack sprayers may be sufficient, and on small bogs with a sufficiently firm bottom a barrel and cart outfit can be used. It is not often practicable to use a team on a bog, not only on account of the very soft bottom but especially because of the injury to vines and fruit. As it is not feasible to haul a heavy power sprayer over the bog, some other arrangement must be made.

The most generally satisfactory outfit yet devised for the rapid, effective, and economical spraying of extensive areas of bog is a large gasoline engine sprayer with stock-supply tanks mounted on a separate truck, which may be moved to convenient points on the margins of the bog or dams, where water may be pumped directly from the stream or ditch into the mixing tanks. Where the bog is not too large it may be sprayed by hose direct from the pump, moving the outfit about the margin of the bog or dams when necessary. The spray mixture may then be distributed to various parts of the bog through galvanized-iron pipes arranged about the margin of the bog and across it in such manner that by means of long leads of hose connected at different points all parts of the bog may be reached.

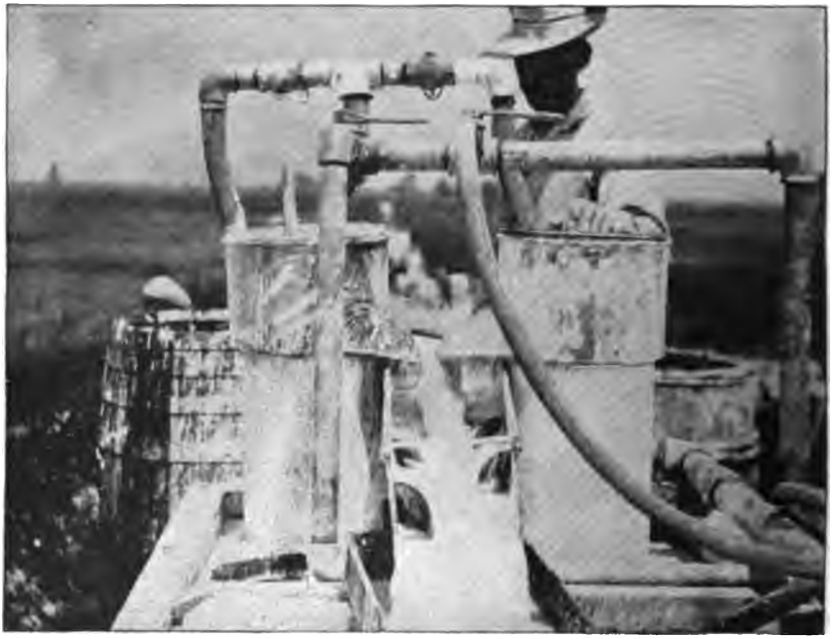

FIG. 10.—Device for making Bordeaux mixture. Pulverized bluestone is being dissolved in one compartment and lime in the other, the two solutions running together in the trough below.

The capacity of the engine, pumps, and tanks will depend upon the area to be sprayed and the number of spray nozzles which can be most effectively used. The following description and illustrations of an outfit used on a large bog in New Jersey will indicate the essential features. Those planning to install a spraying system for cranberries should inspect and study some satisfactory outfit already in operation in order to learn all the essential details and decide just what is necessary to adapt the system to their particular conditions.

The outfit referred to, with two trucks, engine, pumps, and tanks, is shown in figure 9. A 9-horsepower gasoline engine and a 3-cylinder high-pressure pump are used; also a centrifugal pump to fill the tanks. On the rear truck are two 200-gallon tanks and a mixing outfit. The arrangement for dissolving and mixing the bluestone and lime is shown in figure 10. A quantity of pulverized bluestone sufficient for a tank of spray mixture is placed in one of the vessels, and the necessary quantity of slaked or hydrated lime in the other. These materials are dissolved by pumping water through the hose inserted in the top of each container. The dissolved materials come out of the lateral spouts at the bottom of the vessels and are mixed as they fall into a trough, in the sides of which blocks are inserted to cause the more thorough mixing of the two solutions as they run into the spray tank. To provide a continuous supply of spray mixture one tank is being filled while the other is being used. The pumps are connected with hose with galvanized-iron piping, 1 inch or 1¼ inches in diameter, depending upon the length required to reach around the bog. This pipe is placed on posts about a foot high, to prevent rusting, and extends about the margin of the bog and the dams also if necessary.

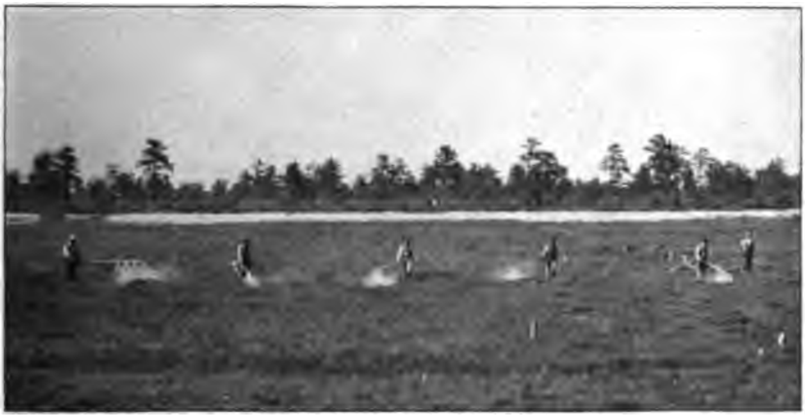

FIG. 11.—A gang of five cranberry sprayers each with a 4-nozzle spray rod.

In the illustration on the title-page the connection of the spray hose to the pipe line is shown; also a hose cart for moving the long leads of hose from one connection to another on the pipe line and for lengthening or shortening the hose according to the needs of the sprayers.

The spray mixture is distributed by a galvanized-iron spray rod with four or five nozzles attached at intervals near one end, as shown in figure 11. The spray hose is carried from the reel across the bog on a series of short posts with rollers at the top, as shown in the right-hand margin of the illustration.

Two hose reels and two gangs of nine men are used with this outfit. The two gangs under favorable conditions can cover 8 acres an hour, using about 200 gallons of spray material to the acre. The usual maximum area sprayed is 60 acres a day, as some unavoidable interruptions of the work are likely to occur. This general plan can be adapted to any large bog.

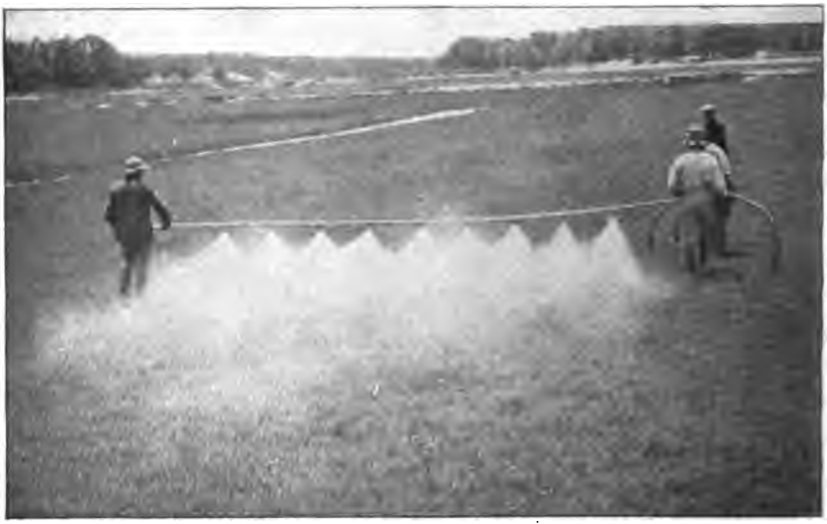

FIG. 12.—A galvanized-iron spray rod with nozzles attached at equal distances on the under side.

Another style of spray rod, shown in figure 12, is used by some growers. This consists of a galvanized-iron pipe with a number of nozzles attached at regular intervals on the under side and carried by two men. This is very satisfactory for medium-sized bogs and fewer men.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

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FARMERS' BULLETIN 1082
UNITED STATES DEPARTMENT OF AGRICULTURE

Home Supplies
Furnished by the Farm

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THE FARMER, unlike most men in other lines of work, has two kinds of income, one his regular cash income, the other an income that is almost never measured in dollars and cents. This bulletin deals with the latter.

Food, fuel, and shelter are three essentials of life that go to make up the part of the farmer's return which does not show on his balance sheet. These are the things that lend safety and stability to farm life; that enable the farmer to tide over bad years and hard times that would be ruinous if he had to pay cash for everything that he gets. In the case of the man on the small farm, this unledgered income is often of as great importance to the farm family as the cash income.

The pictures and text in the following pages are designed to point out the important factors which enter into these direct contributions of the farm to the family living, and to illustrate ways in which they are utilized and conserved.

OFFICE OF THE SECRETARY
Contribution from the Office of Farm Management
H. C. TAYLOR, Chief
Washington, D. C. February, 1920

HOME SUPPLIES FURNISHED BY THE FARM.

W. C. **Funk**, *Assistant Agriculturist.*

IT IS THE PURPOSE of this bulletin to point out the importance of the food, fuel, and shelter furnished the family by the farm. These contributions are not a cash receipt from the farm business, but they enable the farmer to reduce materially the cash cost of living and to continue business even when the financial summary of his operations may show only a small margin of profit at the end of the year, in itself insufficient for the support of his family.

Two-thirds of the farmer's living, on the average, as far as food, fuel, and housing are concerned, is furnished directly by the farm. The food retained for family use may be raised especially for the family or may be taken from the regular farm products raised for market. No farm plan seems complete without its family garden. A part of the day's supply of milk and a part of the day's collection of eggs is used in preparing meals for the family. Similarly, other food products are diverted to the pantry, cellar, or smokehouse, instead of being sent to town to be sold. The farm woodlot, condemned fruit trees, discarded fence rails and posts, and pruning wood furnish fuel for cooking and heating.

These perquisites are not furnished altogether free of cost to the farmer. They represent labor and invested capital. Much of the labor, however, is performed at times when the work of the main farm business is not very pressing, and frequently a considerable part of it is done by women or children. Thus the actual money cost of these things to the farmer is insignificant or at most is considerably less than it would be if they were bought.

In the following pages are presented graphic illustrations of a few of the more important methods followed by farmers in utilizing the food, fuel, shelter, and other things that the farm furnishes free of money cost. These illustrations, of course, are designed to be merely suggestive. Those who wish to get specific figures in this regard are referred to Department Bulletin 410, "Value to Farm Families of Food, Fuel, and Use of House," and Farmers' Bulletin 635, "What the Farm Contributes Directly to the Farmer's Living." Material gathered in the preparation of these publications has been used as the basis of the matter presented in this bulletin.

DAIRY PRODUCTS.

FIG. 1.

DAIRY PRODUCTS constitute the most important group of foods, measured in money value, consumed by the average farm family. Milch cows (fig. 1) are kept on practically all farms. The average farm family uses annually about 2,600 quarts of milk in the form of milk, butter, cheese, or cream.

In dairy regions where milk is shipped or sold to creameries or cheese factories, practically all the butter and cheese used is bought instead of made on the farm. Very few farmers buy whole milk. About four-fifths of the dairy products consumed by farmers are produced on the home farm.

In the South dairy products are used very freely. The common practice is to churn the whole milk for butter, producing a large quantity of buttermilk. The average annual consumption of butter per family is about 230 pounds in the South while for families in the North and West it is less than 150 pounds. It is not unusual for the average-sized family in the South to consume 2,000 quarts of buttermilk a year. Buttermilk is a cooling and healthful drink for that climate.

POULTRY PRODUCTS.

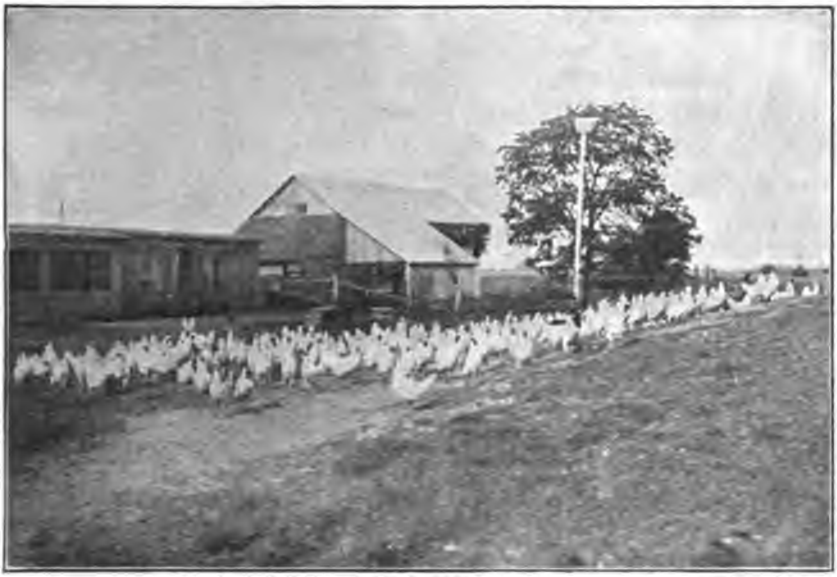

FIG. 2.

A LARGE PROPORTION of the poultry products of this country are produced on general farms. Nearly every farm has its poultry flock (fig. 2). The average American farmer reserves about 3 dozen eggs a week for family use and about 50 fowls are consumed by the family during the year. These food products can be secured absolutely fresh, which considerably enhances the value of this contribution from the farm. Of the meat furnished by the farm to the operator and his family, poultry constitutes about 10 per cent.

A small flock of poultry can be kept on the farm at little cost. The fowls find scattered grain about the farmstead and on the adjoining grain fields after harvest. Garden refuse and kitchen waste are usually available for them. They also feed on insects and worms. In many cases the farmer's wife and children find pleasure in caring for the flock.

PORK.

FIG. 3.

NEARLY two-thirds of the meat eaten on the farm is pork, the average farm consumption of pork being over 500 pounds per family. The greater portion of the pork products used by farmers are produced on the home farm. A small number of pigs (fig. 3) can be raised cheaply. Kitchen and garden wastes, and sometimes dairy by-products, are available for feed. The farmer usually kills the hogs and dresses them on his own place (fig. 4). The hog furnishes a good variety of meat and also lard. The smoke house, a common improvement on the farm, provides a convenient way for curing pork.

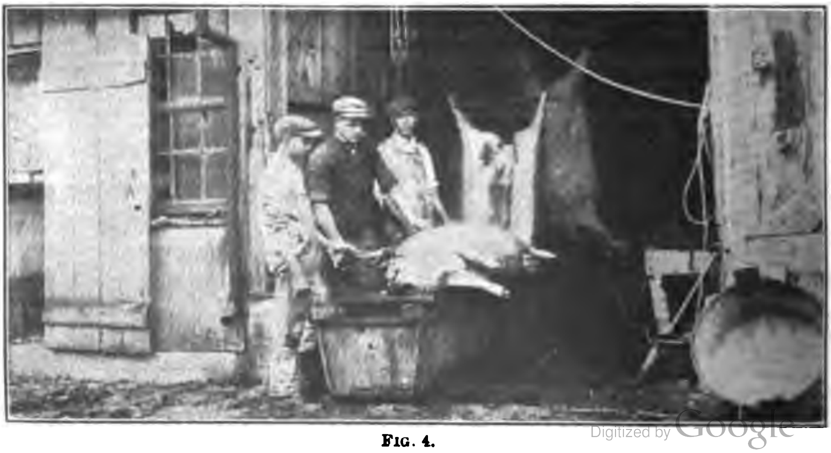

FIG. 4.

BEEF.

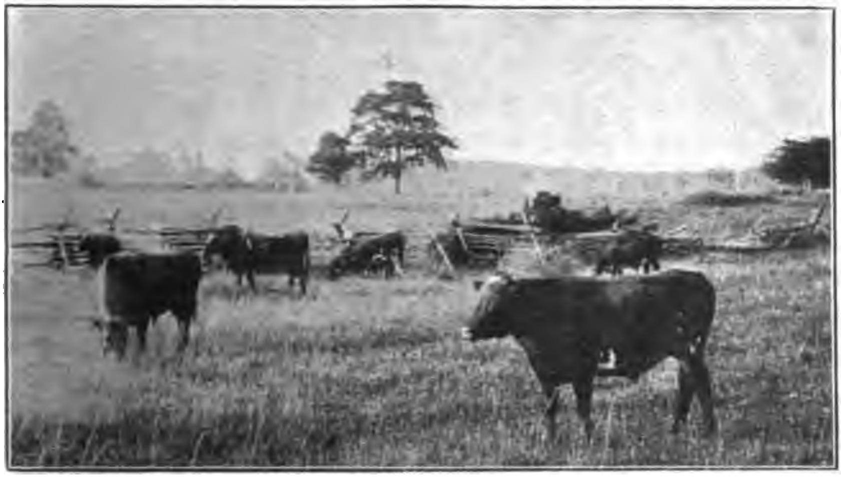

FIG. 5.

THE farmer buys more beef than he takes from the farm. Only about 10 per cent of meat furnished by the average farm is beef. In the North and West the average consumption of beef per family is nearly 300 pounds and in the South it is less than 100 pounds.

The beef animal killed for home use may be a beef steer (fig. 5) or an unprofitable cow, or a heifer that does not promise to be a good producer and would not bring a good price for beef on the market. Very little veal is killed on the farm for home use. Much of the beef bought by farmers is bought in the summer from village butchers who operate meat wagons or cars in the country (fig. 6). On the average farm there are no facilities for keeping fresh meat during warm weather.

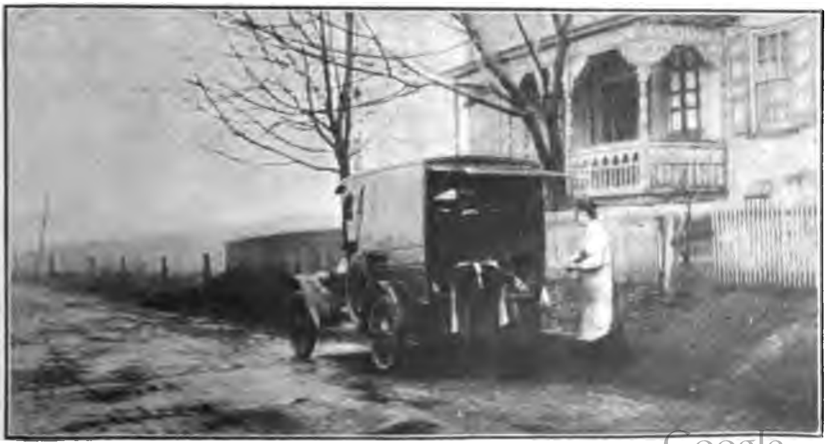

FIG. 6.

SHEEP.

FIG. 7.

SHEEP (fig. 7) are not very generally kept on farms for supplying the home family with meat. There are many areas, especially in hilly or mountainous regions, where nearly every farm could keep a few mutton sheep to advantage. Boys' and girls' clubs in some parts of the country have done much to foster home production of mutton.

"Sheep naturally graze over rather wide areas and seek a variety of plants. This habit particularly adapts them to being kept in large numbers on lands of sparse vegetation or furnishing a variety of grasses or other plants. They do better on short and fine grasses than on coarse or high feed. They will eat a good deal of brush and, if confined to small areas, will do a fair job at cleaning up land. When used in this way, or on land producing brush only, they can not be expected to prove very satisfactory in the production of good lambs or good wool." (Farmers' Bulletin 840.)

THE FARM GARDEN.

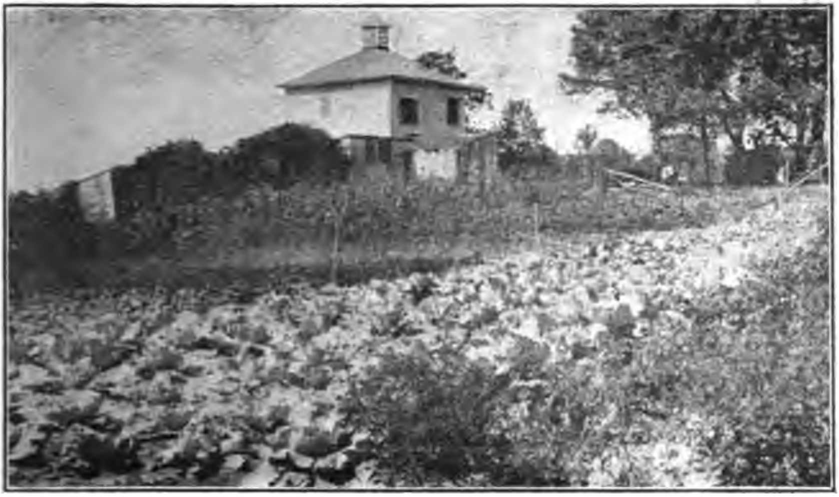

FIG. 8.

THE most intensively worked field on the farm is the garden (fig. 8). For convenience it is usually located close to the dwelling. Many farmers have, in addition, truck patches in fields where intertilled crops, such as corn, are grown. These patches are conveniently plowed, prepared, and cultivated at the same time the ground is worked for the regular crop. In the truck patch potatoes, sweet corn, cabbage, tomatoes, squash, and cucumbers are usually raised.

Vegetables constitute only about 11 per cent (in value) of all food consumed by farmers, and about 80 per cent of the vegetables are furnished by the farm. In general, Irish potatoes are easily the most important vegetable raised, constituting nearly one-half the value of all vegetables consumed. In the South, however, about twice as many sweet potatoes as Irish potatoes are used.

FIG. 9.

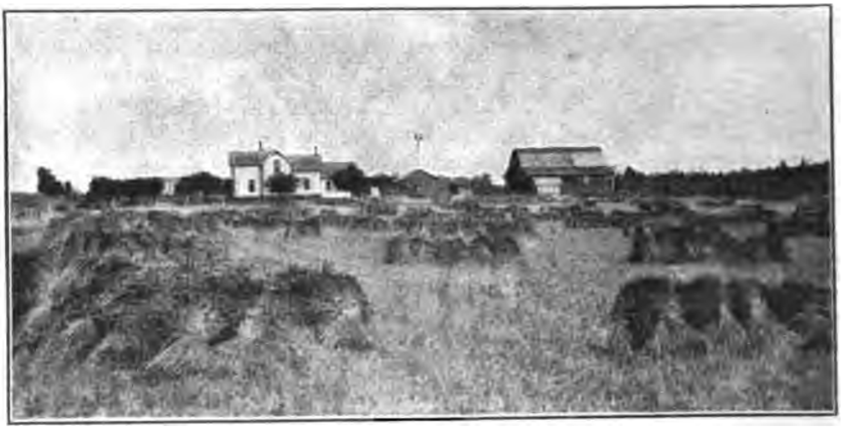

FIG. 10.

FIG. 11.

THE BREAD SUPPLY.

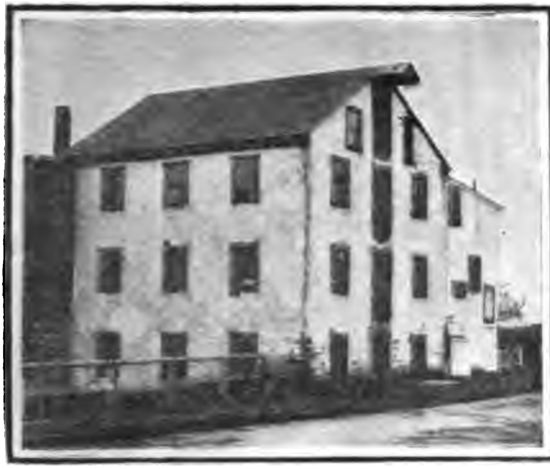

FIG. 12.

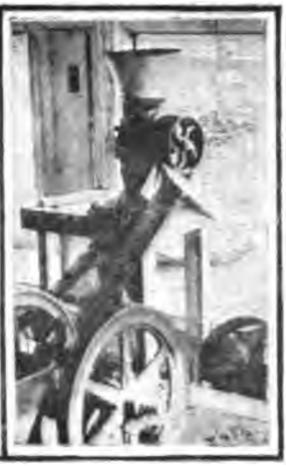

FIG. 13.

CEREALS, such as corn (fig. 9), wheat (fig. 10), and buckwheat (fig. 11), are raised nearly everywhere throughout the United States. These grains are staple breadstuffs, but the general practice of farmers is to buy flour and meal rather than grind or have their own grain ground for home use. In certain sections where custom grist mills (fig. 12) are found, farmers still have some grain ground into flour and meal for home use. Occasionally a farmer is found who has his own little mill (fig. 13) and who makes his own flour and meal.

The average farm family consumes about 6 barrels of flour in a year. In the South the average annual consumption of corn meal is about 500 pounds per family and in the North about 50 pounds. The consumption of buckwheat and rice is low, except in areas where these crops are generally grown, and even there it is usually less than 100 pounds per family. Most farm families use home-baked bread, though in some cases the farmers buy their bread from bakers who drive through the country (fig. 14).

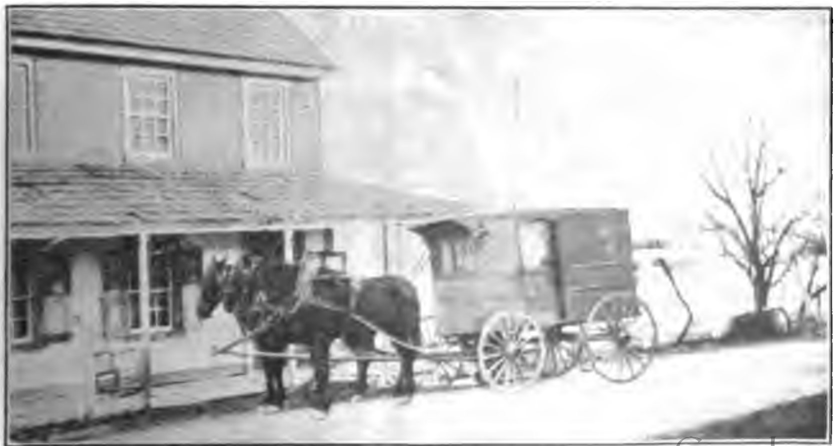

FIG. 14.

SIRUPS.

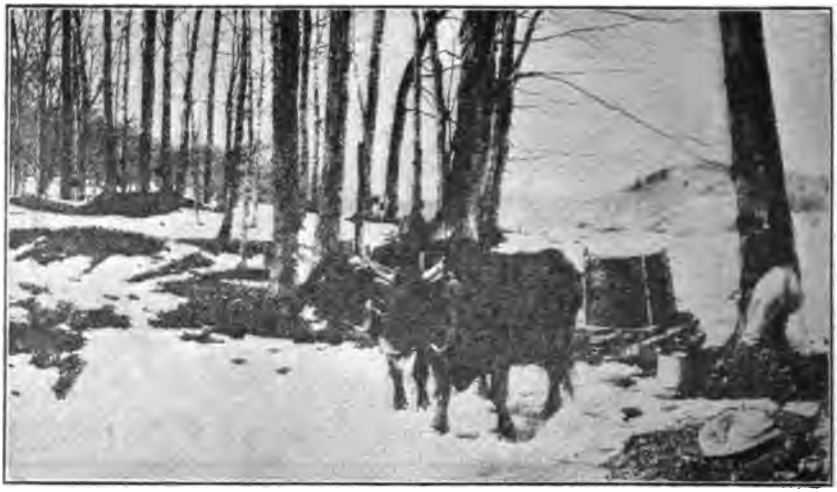

FIG. 15.

IN sections where sugar-maple trees grow (fig. 15), or where sugar cane (fig. 16) or sorghum are grown, the farmer may produce all the sirup the family consumes. Many farmers of the North Atlantic States produce their own maple sirup and in the Southern States the home production of cane and sorghum sirup is even more common. Sorghum is also grown to a considerable extent in parts of the North. It is not unusual for southern families to produce 10 to 25 gallons of sirup for home consumption, making a very important contribution to the family living.

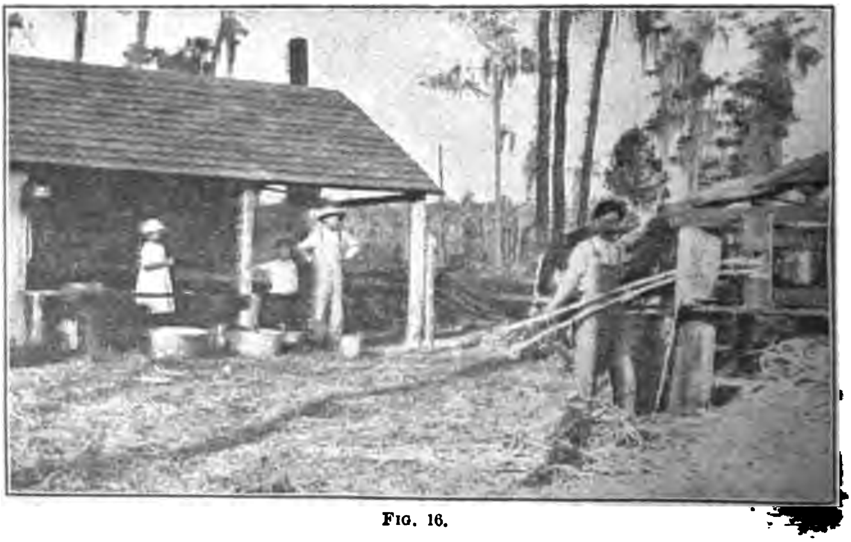

FIG. 16.

FRUITS.

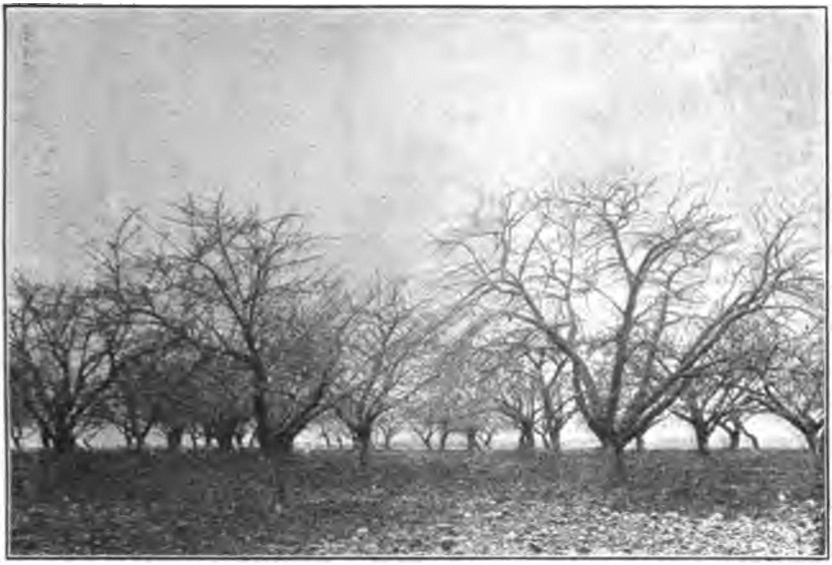

Fig. 17.

THE ordinary individual craves a certain amount of fruit in his diet. On the average farm fruit constitutes only about 6 per cent (in value) of all food consumed. This percentage could be increased to good advantage, making fruit a more important part of the diet.

Many farmsteads include fruit trees and grape arbors (figs. 17 and 18) as a part of the planting scheme around the dwelling. A small area of the farm devoted to apple trees, peach trees, berry plants, or other fruit suited to the region, is a good investment for any farmer. About two-thirds of the fruit consumed by the average farm family is produced on the home farm.

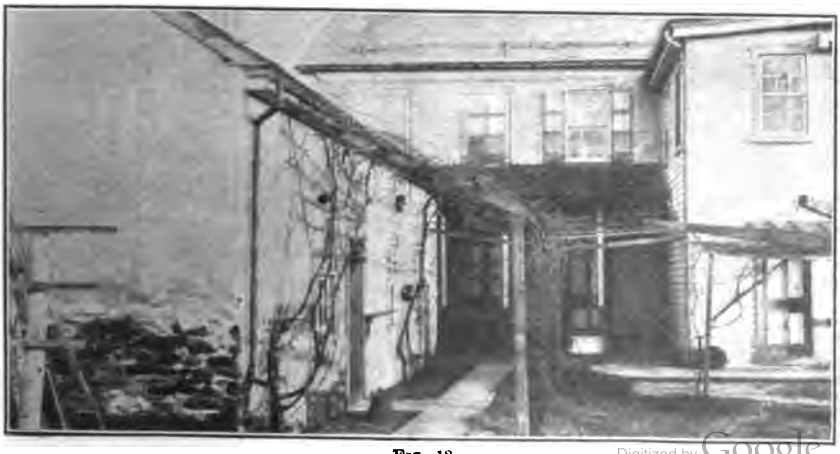

Fig. 18.

CANNING AND DRYING.

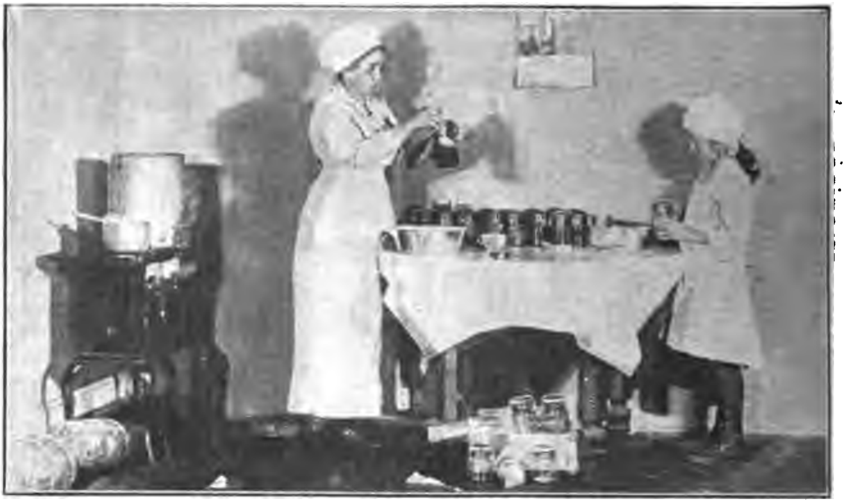

FIG. 19.

IT is particularly desirable to can or dry the fruits and vegetables raised on the farm, as the raw products can be gathered and treated when absolutely fresh and at just the proper stage of ripeness and tenderness for best results.

The average farm family probably cans annually more than 150 quarts of fruits and vegetables, the greater part of which is fruit. Canning clubs have been instrumental in stimulating interest in canning on the farm (see fig. 19, illustrating a Mother-Daughter Club team putting up fruit on the home farm). The drying of fruits and vegetables, an old farm art until recently on the decline, has been revived quite generally within the past two years. This process offers a good means of preserving perishables without entailing expense for containers, as in canning. Figure 20 shows a homemade drying tray.

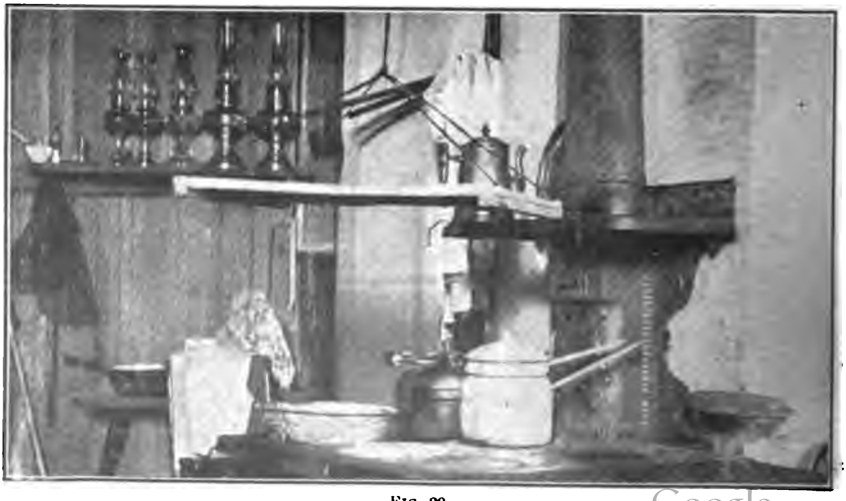

FIG. 20.

FUEL.

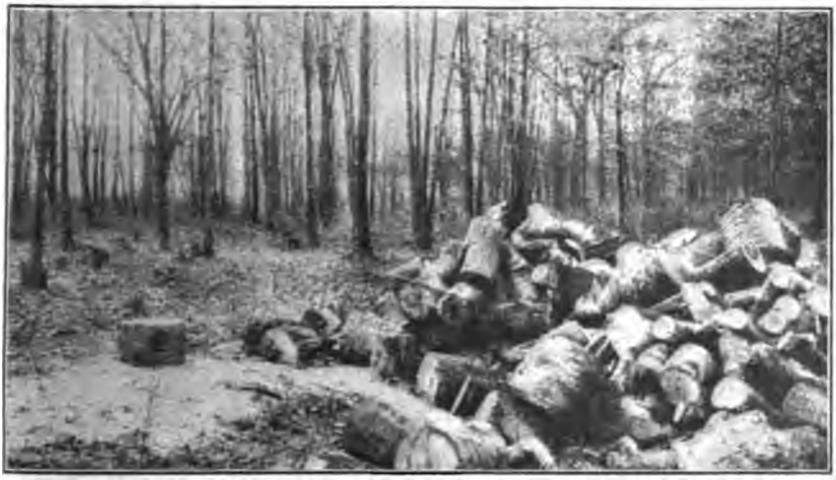

FIG. 21.

ABOUT half the fuel used on farms in general is furnished directly by the farm in the form of wood (fig. 21). The average farm family uses annually between 9 and 10 cords of wood for fuel, in addition to which about 3 tons of coal is bought. The wood, furnished almost altogether by the farm, represents a very considerable item. The farm woodlot should not be overlooked by the farmer in planning for the economical utilization of the resources of his farm (fig. 22).

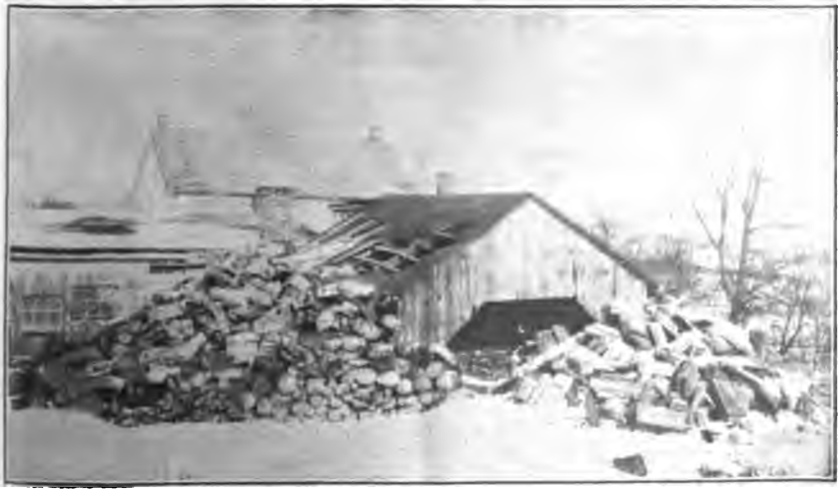

FIG. 22.

STORAGE OF FOOD ON THE FARM.

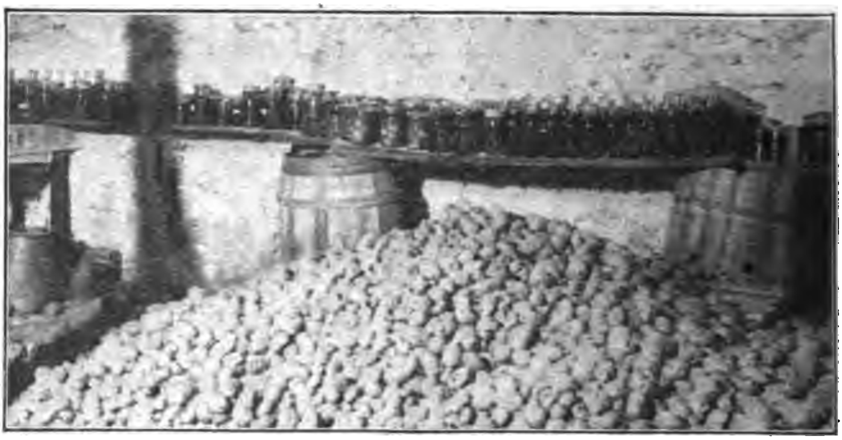

FIG. 23.

FARM buildings usually offer ample space for the storage of food products raised on the farm. The cellar of the house (fig. 23) should hold a winter's supply of potatoes, beets, carrots, onions, and canned fruits and vegetables, as well as such articles as a barrel of salt pork, keg of kraut, and jar of eggs in water glass. The thrifty farmer faces the winter season with a well-stocked cellar and with a store of dried fruits and vegetables and possibly some jars of apple butter (fig. 24) in his attic.

Specially constructed root cellars, or "caves," (fig. 25) may be found on some farms. Potatoes and other vegetables are sometimes carried over the winter in earth pits, or "tumps" (fig. 26). The barn (fig. 27) may also serve as a storage place for vegetables.

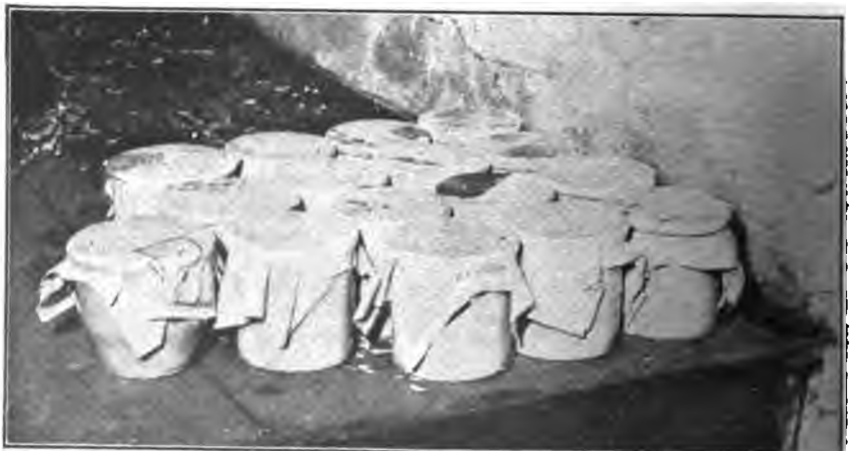

FIG. 24.

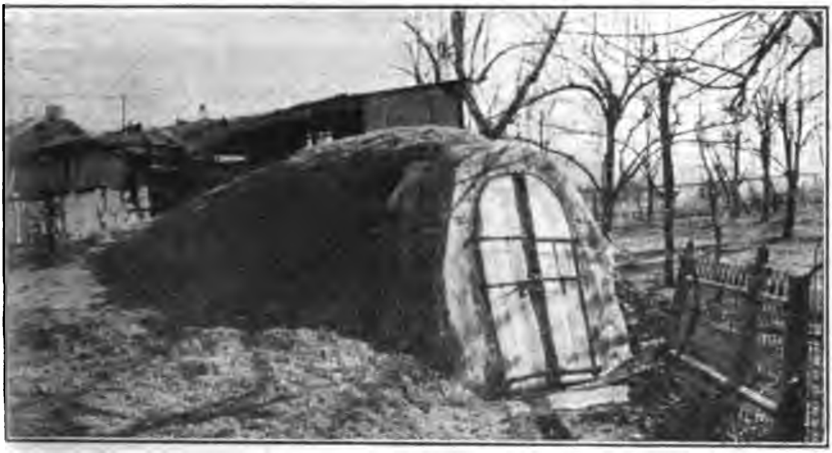

Fig. 25.

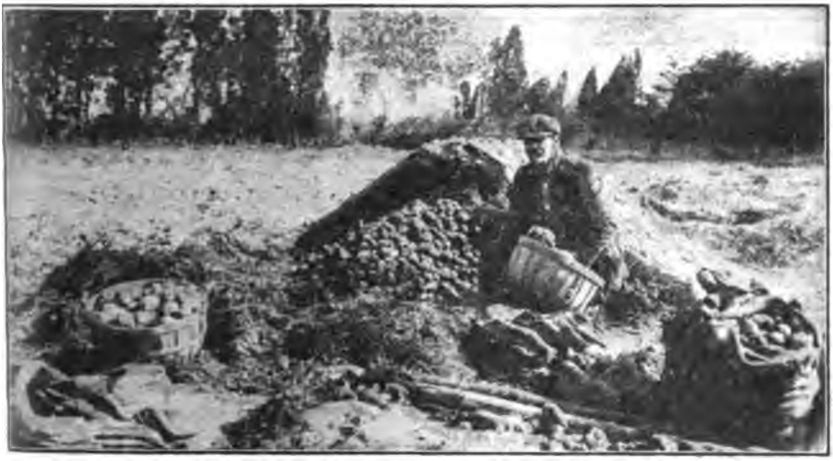

Fig. 26.

Fig. 27.

THE FARM HOME.

FIG. 28.

THE DWELLING is the headquarters of the farm business. Chores are done before breakfast and often after supper, the stock need close attention, certain farm seeds are kept in the house, the hired man may sleep there, and the women folks often take care of the poultry; thus it is almost essential that the house be reasonably close to the other buildings.

The value of the house constitutes an important part of the real estate value of the farm. On the higher-priced Corn-Belt farms and the low-priced Cotton-Belt farms the value of the dwelling represents from 5 to 15 per cent of the real estate value of the farm, while in the eastern part of the United States this percentage is more commonly 20 per cent or over.

The beautifying of the yard by shrubbery, flower beds, and a good lawn involves the occasional use of manure, the introduction of fertile soil, the use of a team and of small farm tools, all of which are available on the average farm.

FOOD CONSUMPTION ON FARMS.

verage quantity of the leading articles of food consumed per family by 950 farm families in 14 different States.

[Average size of family 4.8 adults or equivalent.]

Kind of food.	Home produced.	Bought.
eats:		
Pork and lard........pounds..	499	91
Beef........do....	97	144
Poultry........do....	226	(*)
Fish........do....	....	42
Eggs........dozen..	156	1
airy products:		
Milk........quarts..	770	22
Butter........pounds..	131	32
Cream........quarts..	26	(*)
Buttermilk........do....	425	(*)
Cheese........pounds..	3	13
ruits:		
Apples........bushels..	10	3
Peaches........pounds..	114	66
Plums........do....	15	7
Pears........do....	41	17
Berries........quarts..	39	15
Cherries........do....	22	4
Grapes........pounds..	18	9
egetables:		
Irish potatoes........bushels..	25	3
Sweet potatoes........do....	5	1
Beans........pecks..	11	3
Peas........do....	5	1
Onions........do....	4	2
Cabbage........heads..	44	10
Tomatoes........pecks..	16	3
Turnips........do....	9	2
Sweet corn........dozen..	22	6
Cucumbers........pecks..	4	(*)
roceries:		
Coffee........pounds..	....	39
Sugar........do....	....	382
Flour........do....	76	884
Corn meal........do....	72	76
Bread........do....	....	158
Oatmeal........do....	....	59
Sirups........gallons..	2	7
Honey........pounds..	3	4
Buckwheat........do....	7	7
Rice........do....	....	23

* Less than one unit of measure.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

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THE HESSIAN FLY

AND HOW TO PREVENT LOSSES FROM IT

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FARMERS' BULLETIN 1083

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. March, 1920

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

THE HESSIAN FLY undoubtedly is the most injurious insect enemy of wheat in the United States. During the last 37 years at least seven general outbreaks of this pest have occurred in the States east of the Mississippi River. These invasions have averaged about one every five years, although they have occurred at rather irregular intervals. The last one was very destructive and was at its height during the period from 1914 to 1916.

In some years a toll of approximately $16,000,000 has been taken in Kansas alone, and the average annual damage to wheat throughout the United States has been estimated at $50,000,000.

A large proportion of such losses is preventable, although no remedy is known which will destroy the pest or save the crop once it has become thoroughly infested. Control and preventive measures are described on page 13 and summarized on page 16.

THE HESSIAN FLY[1] AND HOW TO PREVENT LOSSES FROM IT.

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Regions where the Hessian fly is most injurious	3	The so-called bioclimatic law and its application in Hessian-fly control	11
Nature of injury	4	Natural enemies	12
Life history	7	Control measures	13
Description and location of various stages	8	Summary	16

ECONOMIC IMPORTANCE.

IN THE principal winter wheat-growing regions of the United States the Hessian fly is the most injurious insect enemy of the wheat crop. It is generally distributed throughout this territory, except in the extreme south, and is always alert to take advantage of favorable weather and crop conditions to multiply rapidly. Damage amounting to at least $100,000,000 in a single year has been known to occur from its work.

The Hessian fly is chiefly injurious to wheat, but at times injures barley and rye to a lesser extent. It does not attack oats at all. In a few instances, apparently, the insect has been reared from grasses, but it is not known to infest them except under unusual conditions.

REGIONS WHERE THE HESSIAN FLY IS MOST INJURIOUS.

The preferred home of the Hessian fly, generally speaking, is that portion of the country lying east of the one hundredth meridian and between the thirty-fifth and forty-fifth parallels of north latitude. It occurs outside of this area, but usually not as a serious menace to the wheat. The fly also is found in the Pacific Coast region, but is not nearly so destructive as it is east of the Rocky Mountains.

The Hessian fly is found in the Dominion of Canada from Prince Edward Island to Indian Head, Saskatchewan, and also in British

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[1] *Phytophaga destructor* Say; order Diptera, family Itonididae.

Columbia. Outside of America, it is known in North Africa, Western Asia, Europe, Great Britain, and New Zealand.

The map (fig. 1) shows the distribution of the insect in the United States. The common name, "Hessian fly," was bestowed upon this insect long ago by Americans, because of its depredations on Long Island, N. Y., in 1779, in the vicinity of Lord Howe's encampment of three years before. On the supposition that the pest had been brought from their native country in the straw used for their bedding by the Hessian mercenaries who constituted a part of this army, it was given the obnoxious name of "Hessian fly." The pest undoubtedly was imported, probably from some trans-Atlantic country, some time during the latter half of the eighteenth century.

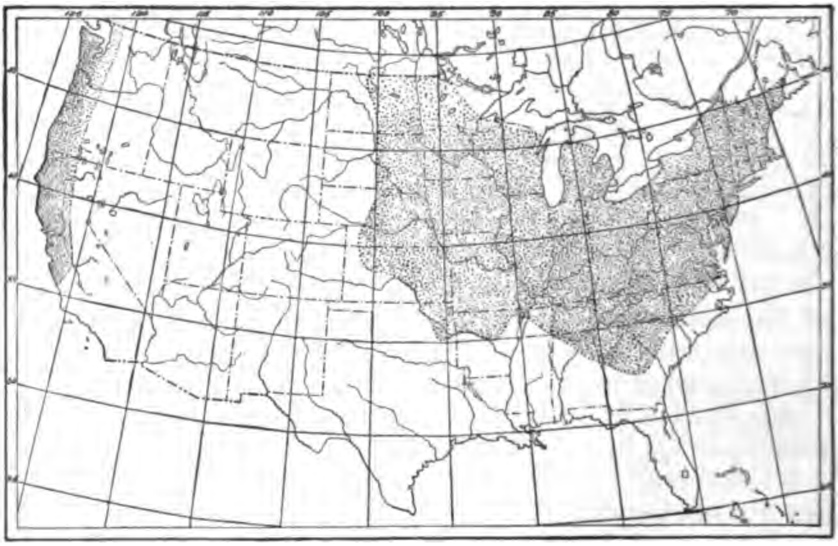

FIG. 1.—Map showing distribution of the Hessian fly in the United States.

NATURE OF INJURY.

The Hessian fly injures wheat and other plants by extracting the juices of the young growing plants and by weakening the stems of the older wheat near the joints and causing it to become "strawfallen" shortly before harvest.

The most obvious damage is caused by the maggot or larva of the spring generation, which lodges between the leaf sheath and the stem above a joint. Frequently several maggots locate above the same joint. The maggots weaken the stem, causing it to become shrunken at their point of contact with it. As the wheat head develops and grows heavy with grain the stem bends or even breaks off at the weakened spot, and the head falls to the ground out of the reach of the harvesting machinery. In cases of serious infestation much of the young wheat is killed outright by the work of the fall brood of maggots.

EFFECT OF LARVÆ ON THE PLANT.

The effect of the feeding of the larvæ on a young wheat plant is very marked and may be observed soon after the young reach the stem under the sheath. Once seen it usually is possible afterwards to detect an infested plant.

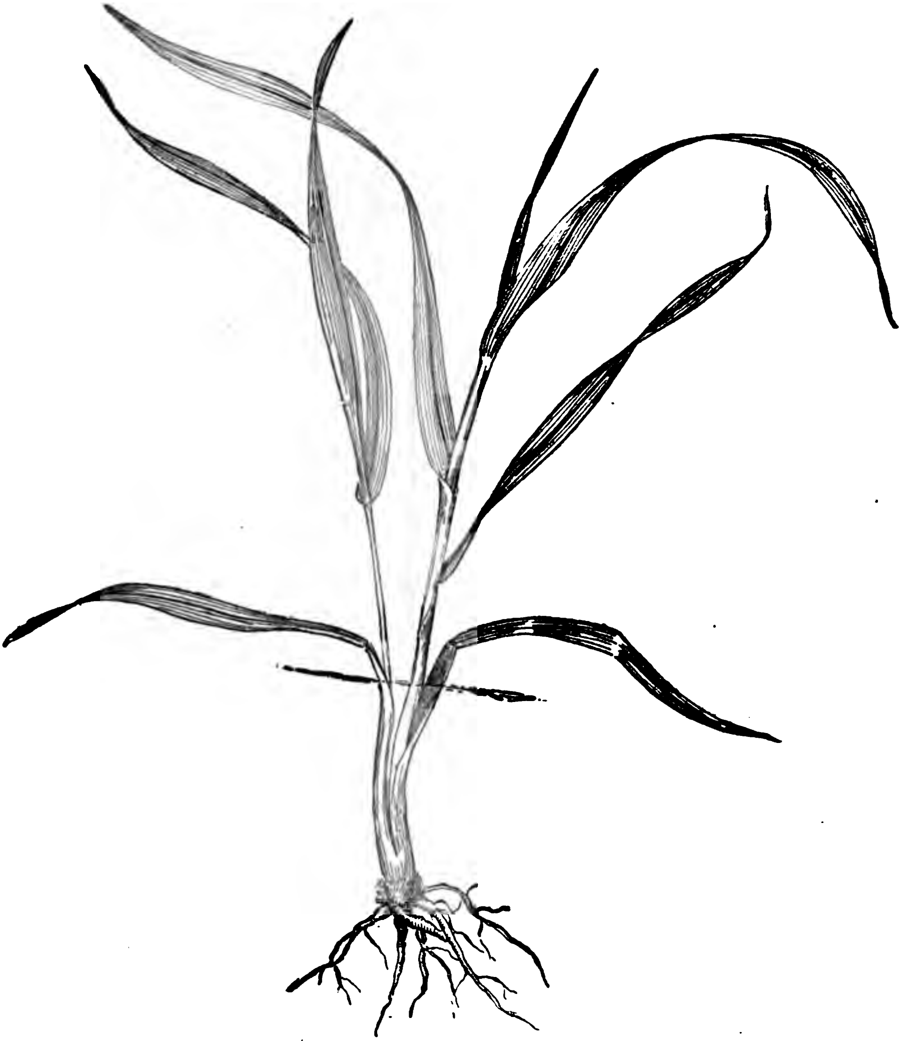

FIG. 2.—Healthy young wheat plant.

For comparison, illustrations are given of a normal young plant (fig. 2) and an infested young plant (fig. 3). An uninfested plant is of a more slender growth, the green color is lighter, with a slight tinge of yellow, the stems are more or less visible, and the central unfolding leaf is present. The whole plant is inclined to droop and the tillers spread out and cover the ground. In an infested tiller the leaves are broader, usually shorter and of a deep dark-green color, somewhat resembling those of oats. The leaves stand more erect and rise directly from the ground without a visible stem. Infested tillers usually perish during the winter. Figure 3 shows a young tiller starting out from below the part attacked by the fly. If this is attacked after it appears above ground it assumes the same appearance as the original plant. Its leaves become broader and of a darker color. The foregoing statement applies equally to

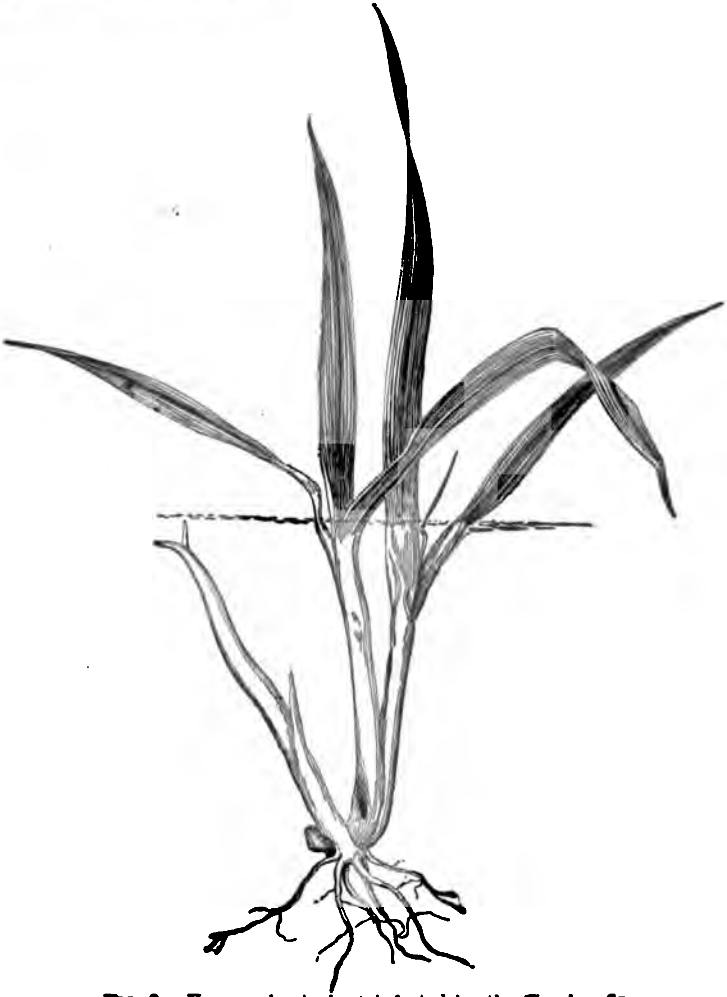

FIG. 3.—Young wheat plant infested by the Hessian fly.

a severe attack on fall wheat in spring or on young spring wheat. The only exception in the appearance of infested young plants is in the case of the hard wheats, whose foliage is naturally of a darker color, but the erect position will still enable the observer to detect the infestation. Of course, later on the infested plants change to yellow and then brown, but the darker color and rank growth of leaf always precede this.

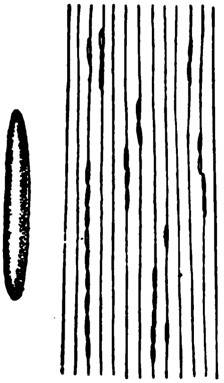

Fig. 4.—Egg of Hessian fly, greatly enlarged; section of leaf of wheat, at right, showing eggs as usually deposited, less enlarged.

LIFE HISTORY.

In the winter-wheat regions of this country the Hessian fly usually has two principal generations annually. In the South the two generations are the most widely separated, while in the North, in the regions of spring-wheat growing, one generation seems to follow the other in quick succession.

Throughout the winter wheat-growing sections the fly passes the winter in the young wheat, mostly in the resting or "flaxseed"[1] stage, but in mild winters to some extent as larvæ from two-thirds to full grown.

In spring (from March in Georgia and South Carolina to May in Michigan) the flies escape from the "flaxseeds" in these young plants, deposit their eggs on the wheat (fig. 4), and the young from these develop to "flaxseeds" (fig. 5) before harvest, passing the summer in the stubble. During some seasons and in certain localities there occasionally appears just before harvest what has by some been considered a "supplementary" second brood of flies, consisting of a fractional part of the spring brood, the development of which has been delayed.

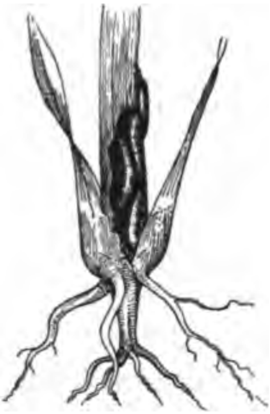

Fig. 5.—Hessian fly "flaxseeds" on young wheat. Much enlarged.

In autumn the order of appearance of flies is reversed. In northern Michigan the flies of the fall generation may be found, under normal meteorological conditions, during the last days of August and first days of September. In Georgia and South Carolina, under the same conditions, it may be the last of November or the first of December before they have all left the stubble. Thus has this insect adapted itself to the prolonged southern summer, during which there is little or no food for the larvæ. While there are stragglers, the major part of the generation usually appears and disappears within the space of a week or so, and the flies, by preference, deposit their eggs on the younger plants, those with one or two leaves seeming to suit them best. When hatched at this time of the year the young maggots make their way downward nearly or quite to the roots (fig. 6). Normally these individuals complete their development as larvæ, pass into the "flaxseed" stage, and spend the winter as such on the young wheat plants (fig. 5). The earliest-deposited eggs on the earliest-sown wheat, however, under favorable conditions may produce adults before the winter sets in, and the delayed individuals of the fall brood of flies occurring at this time combine with them to produce another so-called "supplementary generation." The importance of this "supplementary generation," so called, depends much on the weather. If winter sets in before the larvæ have matured sufficiently to withstand its rigors, these necessarily perish, while if the mild autumn weather is greatly prolonged, a greater or less number of them may winter over uninjured.

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[1] The so-called "flaxseed" of the Hessian fly is described in detail on page 9.

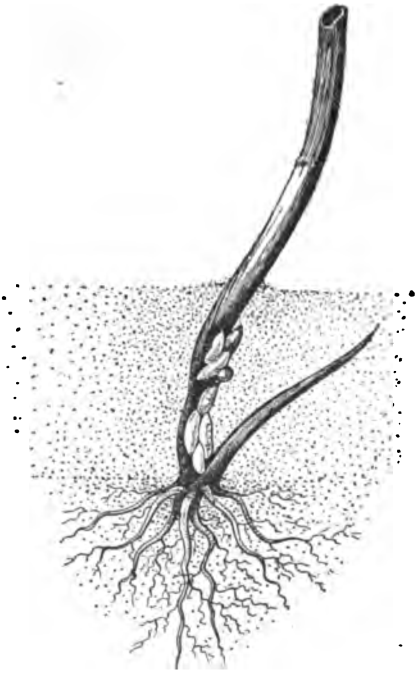

FIG. 6.—Hessian fly maggots beneath sheath in the soil. Enlarged.

It has been found, under certain weather conditions, that in fields containing volunteer wheat partial generations of the fly may occasionally appear. These are known as "supplementary broods," and it is possible for the earliest flies in volunteer wheat to emerge and reinfest the winter wheat.

DESCRIPTION AND LOCATION OF VARIOUS STAGES.

The egg (fig. 4, at left) is very minute, being only about one-fiftieth of an inch in length, but it may be readily seen by one having ordinarily good sight. It is slender and almost cylindrical, with both ends bluntly rounded. The surface of the egg is glossy and its color a shade of vermilion red, which deepens with age. The eggs are generally placed in the grooves of the upper surface of the leaves (fig. 4, at right).

The newly hatched larva is slightly smaller than the egg and has the same general color, but this changes to white within a few days. Immediately after it is hatched it makes its way down the leaf and behind the sheath. In the case of young wheat it descends to just above the roots, but after the plants have begun to joint it can go no farther than the base of the sheath belonging to that particular leaf, which is always at the joint. Where excessively abundant the larvæ crowd together side by side or behind one another under the same sheath. This condition usually accompanies a heavy infestation.

The fall generation of larvæ and the overwintering "flaxseeds" are to be found just above the roots and below the surface of the ground (fig. 6). In the spring generation the larvæ, or "flaxseeds," are to be found in different locations, depending apparently upon atmospheric conditions. Thus in the eastern or more humid regions they usually occur near the joints at some distance above the surface of the soil, but in the western and drier portions of its range the insect locates lower down the stem, and may be found beneath the sheaths at or even below the surface of the soil (fig. 6).

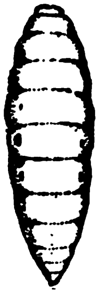

FIG. 7.—The Hessian fly: Larva before "flaxseed" is formed. Greatly enlarged.

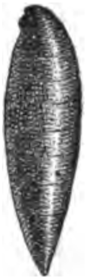

FIG. 8.—The Hessian fly: Puparium or "flaxseed." Greatly enlarged.

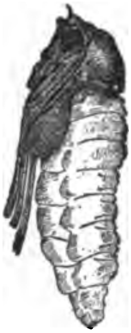

FIG. 9.—The Hessian fly: Pupa taken from "flaxseed." Greatly enlarged. (Marlatt.)

When the larva becomes full grown it is naked, glistening, and white in color (fig. 7). The skin soon hardens and turns brown, and the insect then resembles very closely a flaxseed (fig. 8), and often is referred to by that name. This is not the pupa (fig. 9), which is formed subsequently, after the larva has reversed its position and lies with the head pointing upward.

Before the fly issues, if the "flaxseed" is not situated conveniently for the emergence of the adult, the pupa pushes itself, if possible, to such a point of escape, and frequently empty pupa skins may be observed protruding from under the sheaths of leaves.

The fly itself is not easily observed until one becomes familiar with its appearance and looks for it at the right time. These facts account for the great variety of insects that are continually mistaken by growers for the Hessian fly. Much of this confusion may be obviated if search is made for an insect like that shown in figures 10 and 11, but very minute and somewhat resembling a mosquito. During warm days, in the egg-laying season, the flies may be observed flying about in the young wheat, alighting upon the leaves. On cooler days, or in early morning while a heavy dew is on, they are down among the leaves or even on the ground. The adult flies live only a few days, depending somewhat upon temperature conditions.

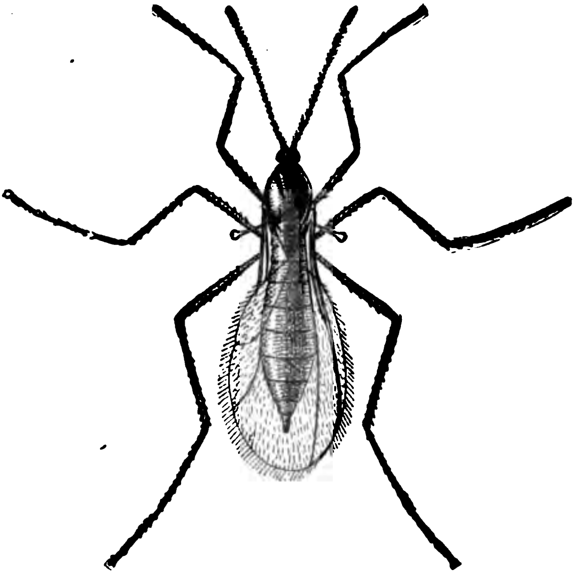

Fig. 10.—The Hessian fly: Adult female. Greatly enlarged.

EFFECT OF THE WEATHER ON THE HESSIAN FLY.

All who have studied the Hessian fly carefully under various field conditions during a series of years have noted that weather conditions have an important influence on the insect, and in the application of preventive measures these weather conditions become of vital importance.

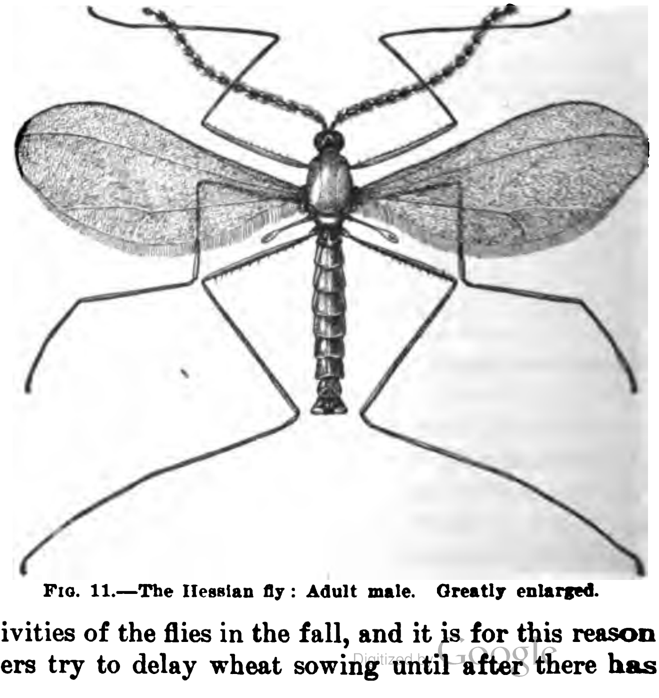

Fig. 11.—The Hessian fly: Adult male. Greatly enlarged.

Many wheat growers believe in the effectiveness of cold weather or even of frosts in terminating the activities of the flies in the fall, and it is for this reason that many growers try to delay wheat sowing until after there has been a sharp frost. The facts are, however, that the females may be found ovipositing in rather cold weather, and the eggs have been known to remain in a temperature of 36° F. for 72 hours with no other effect than to delay their hatching that much longer. Eggs have been observed hatching during the day in the fields when there were frosts nearly every night. It should be understood clearly that the immunity of late-sown wheat from attack by the fly is not due to frost, but to the fact that by the time severe frosts occur most of the flies usually have disappeared.

The most marked influence of climatic conditions on this insect is seen in the effect of heat and drought, and especially of the two combined. Heat and drought delay the emergence of the adult Hessian flies in the fall. This fact is of special importance in the North, where it is necessary to get the wheat sown early enough to enable the plants to stand the severe weather. The larvæ in the "flaxseed" form have been known to survive for more than two years and afterwards to emerge as adults.

THE SO-CALLED BIOCLIMATIC LAW AND ITS APPLICATION IN HESSIAN-FLY CONTROL.

Many years ago it became known, through experiments conducted in Ohio by the late Prof. F. M. Webster,[1] that wheat sown on certain dates in the fall was usually immune to infestation by the Hessian fly. It was established that these dates became later at a more or less uniform rate as one progressed southward.

About a year later Dr. A. D. Hopkins[2] published information showing the rate at which the safe date varied with latitude and elevation above sea level. Recently he has shown that these safe sowing dates vary also with longitude.[3] The law as at present understood[4] and as applied to the safe sowing dates is as follows:

> **The law is founded on the determined country-wide average rate of variation in the time at which periodical events, such as the emergence of the adult Hessian flies, occur at different geographical positions. Other things being equal, this variation is at the rate of four days for each degree of latitude, five degrees of longitude, and 400 feet of altitude. Therefore, from any given place, as related to a State or county, the variation in a given periodical event is (at the rate stated) earlier northward, eastward, and upward during the fall wheat-sowing period.**

There are many regional and local influences which cause more or less departure from the averages. Therefore, in the application of the law to the selection of the safe-sowing date for any given locality, it is necessary for the grower to be guided by a specially prepared calendar of dates and rules for local application or to utilize some natural guide which, on his particular farm, is coincident with the safe time to sow wheat to escape damage from the fly.

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[1] WEBSTER, F. M. THE HESSIAN FLY. Ohio Agr. Exp. Sta. Bul. 107. May, 1899.

[2] HOPKINS, A. D. THE HESSIAN FLY IN WEST VIRGINIA AND HOW TO PREVENT LOSSES FROM ITS RAVAGES. W. Va. Univ. Agr. Exp. Sta. Bul. 67. August, 1900.

[3] Anyone who wishes to go more deeply into the matter should consult the Monthly Weather Review Supplement No. 9, Weather Bureau, U. S. Department of Agriculture, May 1, 1918.

[4] Scientific Monthly, June, 1919, p. 496.

Doctor Hopkins states that unpublished results of his recent experiments indicate quite conclusively that the first general coloring of the foliage, especially on the hickories, dogwood, birch, ash, etc., is, as a rule, coincident with the safest and best time to begin sowing wheat on any farm within the range of winter wheat culture.

Probably the safest and most convenient way for the wheat grower to secure the necessary information is to communicate with the nearest agricultural experiment station, requesting information as to the safe date for sowing wheat in his immediate locality. County farm advisers usually can secure such information promptly and are willing to aid in distributing it to the farmers of their respective counties.

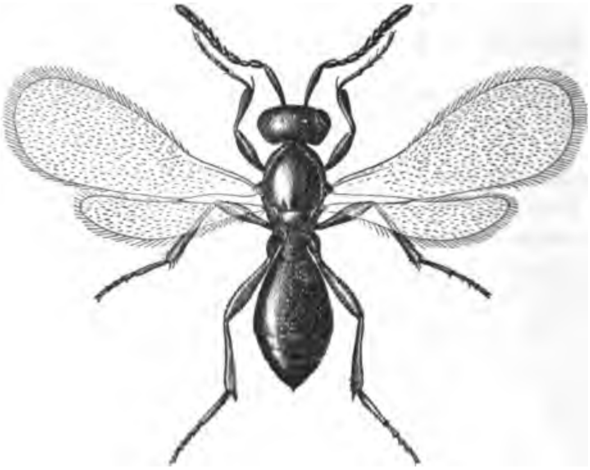

FIG. 12.—*Polygnotus hiemalis*, a parasite of the Hessian fly. Much enlarged.

NATURAL ENEMIES.

There can be no doubt that parasites play a most conspicuous part in the natural control of the Hessian fly, and if we only knew the whole truth of the matter we should find that these minute friends of the farmer are worth many times their weight in gold. Not infrequently one species of these parasites overcomes the pest in a neighborhood so effectively as almost to exterminate it. Very little is yet known regarding the laws that govern the supply of these insect enemies of the Hessian fly, and wheat growers should not rely upon them for material help. It is necessary for growers to practice at all times the preventive measures recommended in the following pages.

Polygnotus hiemalis Forbes (fig. 12) perhaps is more useful than any other insect parasite in this country in the natural control of the Hessian fly, and a considerable number of the larvæ have been observed within a single "flaxseed." The adult is black, with yellow feet and dark brown legs.

Another parasite reared almost invariably in connection with the Hessian fly is *Eupelmus allynii* French (fig. 13). It is known to be of considerable importance, although sometimes acting as a secondary parasite; that is to say, as a parasite of another Hessian fly parasite, and thus becoming injurious.

More than 20 species of insect parasites are now known to be concerned at times in the control of the Hessian fly in this country, but many of them apparently are of little importance under most conditions.

CONTROL MEASURES.

ALL USEFUL MEASURES PREVENTIVE.

Of direct remedies for the Hessian fly there is little to be said, since after the pest becomes established in a field it can not be reached by any measure likely to destroy it. The application broadcast of some quick-acting fertilizer, as soon as general infestation is apparent, may cause the plants to tiller more freely and give them sufficient vigor to withstand the winter and thus increase the number of healthy stems the following spring.

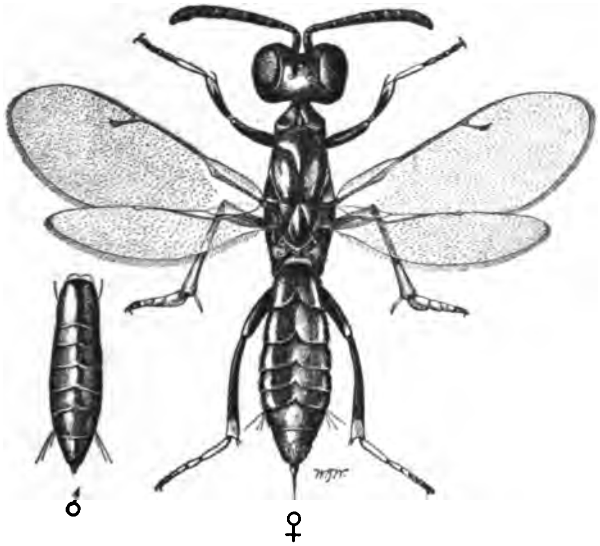

Fig. 13.—***Eupelmus allynii*, a parasite of the Hessian fly: Female, with male abdomen at left. Much enlarged.**

All useful measures necessarily must be in the nature of preventives, keeping the pest from attacking young wheat in the fall, and increasing the vigor of the young plants in order to enable them to counteract the insect's effect when present. Under the first category come late sowing, rotation of crops, the plowing under of stubble, and the destruction of volunteer wheat. Under the second should be classed the enrichment of the soil, its thorough preparation, and the selection and proper sowing of the best seed.

CROP ROTATION.

For Hessian fly control wheat should not be grown on the same land two years in succession, where it is practicable to avoid this, as the continuous planting of wheat increases infestation not only by the Hessian fly, but also by other insect pests which infest wheat stubble, such as the jointworm, the strawworm, and the wheat-stem sawflies. Such a rotation of crops should be practiced as is approved by local farm advisers or State experiment stations.

PLOWING DOWN STUBBLE.

The plowing under deeply and thoroughly of all infested wheat stubble soon after harvest is a useful practice in the control of the Hessian fly. It can not and should not be practiced, under existing systems of rotation, wherever this seriously interferes with the growing of clover or the forage grasses necessary for maintaining the proper tilth of the soil. This caution is applicable to most of the Northeastern States where the practice of sowing clover or grasses with wheat is common. In regions subject to Hessian fly injury, plowing under of stubble, where it can be practiced, however, has been found to aid materially in reducing the abundance of the pest. The plowing must be deeply and thoroughly done to be of avail. The plowed surface should be rolled afterwards or lightly harrowed to close the openings in the soil and prevent the flies from emerging.

DESTRUCTION OF VOLUNTEER WHEAT.

Volunteer wheat acts as a breeding place for the Hessian fly between regular crops and should be thoroughly eliminated by disking, plowing, or some other method.

This is very important if the main crop of wheat is to be saved from the ravages of the fly.

PROPER PREPARATION OF THE SOIL.

It matters little whether a soil has much or little fertility if that fertility is bound up in clods or hard lumps out of reach of the rootlets of the young plants. Early plowing and thorough working and compacting of the soil eliminate the lumps and clods and produce a finely pulverized, compact, moisture-conserving seed bed, from which, as soon as rootlets are sent out from the seed kernel, the shoot begins to draw nourishment. This gives vigor to the plants and thus enables them, by freely tillering, to outgrow a light attack of the fly that otherwise might prove serious.

CONSERVATION OF MOISTURE.

The seed bed should be prepared in advance of seeding. If rain occurs before the date set for sowing, the ground should be harrowed so that the wheat will germinate promptly, even if weather should turn dry. This is an important point frequently overlooked by growers.

THE USE OF GOOD SEED.

As the seed kernel contains sufficient nutriment to put out and sustain rootlets until these can begin to draw from the soil and thus support the stem, any deficiency in the seed necessarily tends to weaken the plant at the very beginning of its existence. Thus good seed becomes the first requisite in securing the healthy, vigorous plant that is to be further strengthened and sustained by a well-prepared, fertile soil. It is clear then that all shrunken, dwarfed, or otherwise imperfect kernels or weed seed, especially cockle, should be cleaned out of the seed before it is sown and only the largest and most perfect retained.

ENRICHING THE SOIL.

Wheat growing in fertile, rich soil withstands Hessian-fly injury much better than that growing in poor soil. This is true also of jointworm injury. Therefore keep the soil of wheat land in good tilth at all times by following the methods approved by agricultural experts for your particular locality.

DATE OF SOWING.

Late sowing as here recommended means moderately late sowing of fall wheat in any locality, because extremely late sowing, which sometimes has been advised, is even worse than early sowing. Experiments conducted over a period of many years have shown that in most localities the safe date for sowing winter wheat to escape Hessian fly injury in years of normal rainfall usually coincides with the proper time for sowing in order to secure maximum yields of grain. These dates as determined for some localities are as follows:

In northern Michigan, soon after the 1st of September.
In southern Michigan and northern Ohio, about September 20.
In southern Ohio, after the first week in October.
In extreme northern Illinois the safe period usually occurs from September 21 to 28.
In central Illinois and Indiana, from September 21 to 30.
In extreme southern Illinois, from September 30 to October 5.
In central Kentucky, from October 5 to 15.
In central Tennessee, from October 15 to 25.
In Georgia and South Carolina, from October 25 to November 25.
In northeastern Kansas the safe period is from October 1 to 10.
In east-central Kansas, usually from October 1 to 20.
In extreme southern Kansas and northern Oklahoma wheat should not be sown until the second week in October.
This is true also of Virginia near sea level.

October-sown wheat always enjoys the greatest freedom from the fly in Maryland, except in the mountainous regions where earlier planting is necessary.

In southeastern Pennsylvania the safe period is during the last week of September, and practically the same corresponding delay in wheat sowing in the fall should be followed to the southward.

These dates are only approximate, and serve to show in a general way about the time when the fall brood of the fly disappears. All are dependent upon latitude, altitude, longitude, and other local conditions. The date varies considerably in broken or hilly country, even on the same farm, being appreciably later on the southern slope of a hill than on the northern slope of the same hill at the same elevation. Because of the fact that the larger part of the fall brood appears and is gone within a week or so, it is possible so to time the seeding of winter wheat as to avoid the Hessian fly, and this is one of the most practical and effective measures that can be applied.

SUMMARY.

There is no remedy for the Hessian fly when once it takes possession of a crop of wheat.

Injury can be prevented in only one way, namely, by keeping the fly out of the wheat.

The following methods are reliable and should all be observed where it is possible to do so:

1. Practice crop rotation. Do not sow wheat on stubble if it is possible to avoid doing so.
2. Plow under all infested stubble, where practicable, soon after harvest. Plow ruined wheat as soon as possible after it has been determined that the crop will be a failure.
3. Destroy all volunteer wheat by harrowing, disking, plowing, or some other method.
4. Plow all land to be sown to wheat as early and deeply as existing conditions permit, and prepare a thoroughly pulverized and compacted seed bed.
5. Conserve moisture against a period of drought at seeding time.
6. Use good seed.
7. Fertilize.
8. Sow wheat during the fly-free period as advised by your farm adviser or State experiment station.

Adhere to these practices every year whether the fly is abundant or scarce. They will help to keep it scarce.

Community cooperation is essential if success is to be attained because one infested field may furnish enough flies to damage the wheat for several miles around.

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CONTROL OF AMERICAN FOULBROOD

E. F. PHILLIPS
Apiculturist

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FARMERS' BULLETIN 1084
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. March, 1920

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

AMERICAN FOULBROOD is a disease of the brood of bees which is causing great losses to American beekeepers. It has existed almost since bees were first brought to North America.

It is important that the beekeeper should know whether American foulbrood or European foulbrood is in his apiary, for the two do not respond to the same treatment.

In American foulbrood control it is necessary that all combs, honey, and other materials from the inside of the hive be taken from the bees and that a chance be given them to establish themselves again on new combs. Several methods are given in this bulletin, but the underlying principle is the same in all cases.

No measures which the beekeeper may take will put his bees in such condition that they will not contract this disease, but by guarding them from infection he may save himself much worry and financial loss.

The facts about the disease on which the treatment is based are discussed in this bulletin and the treatment is described in full.

CONTROL OF AMERICAN FOULBROOD

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IMPORTANCE OF EARLY DETECTION.

GREAT LOSS and considerable anxiety among beekeepers in many parts of the country have been caused by the disease known as American foulbrood. The symptoms have long been known and the treatment now in general use was discovered hundreds of years ago, yet there are beekeepers who fail to distinguish this disease from the other brood diseases, especially European foulbrood. The disease has existed in America almost as long as bees have been kept here, but the progress in commercial beekeeping of the last half century has resulted in greatly extending its distribution.

Colonies in an apiary often become infected before the owner realizes that disease is present. He may erroneously attribute the losses observed to some other cause. In this way the disease, before it is discovered, gets a start which makes eradication difficult. In view of the widespread distribution of American foulbrood, it is most desirable that all beekeepers learn how to recognize it when it appears, how to distinguish it from European foulbrood, and how to keep the diseases under control.

NAME OF THE DISEASE.

When American beekeepers first observed this disease they gave it the name "foul brood," by which it had long been known in Europe. With the discovery of another brood disease in New York in 1894, or rather with the recognition of the difference between the two diseases, considerable confusion arose regarding the names of the various troubles. This was increased by the work then done on the causes of the two diseases, the trouble lying in the erroneous results of still earlier work on the organisms found in the diseased material. After consultation with beekeepers and apiary inspectors, it was decided to adopt the name American foulbrood for the disease which had been known in this country for so long.

The name was first used in a circular[1] of the Bureau of Entomology and has been generally accepted by beekeepers throughout this country and in other countries. The adjective "American" was chosen because it appeared that this disease was first subjected to a thorough investigation from the bacteriological standpoint by an American investigator, while the other serious disease of the brood of bees had been investigated previously in Europe. The names obviously are not intended to convey the idea that the diseases originated one in America and the other in Europe, for the honeybee is not native to America. The names were chosen simply that beekeepers might have names which could be used with safety, and which would not lead to confusion by being descriptive.

SYMPTOMS.

The beekeeper who discovers a brood disease among his bees should know whether he has to deal with American foulbrood or European foulbrood, for they do not respond to the same treatment. The symptoms of American foulbrood are the outward manifestations of the disease, being simply the appearance of the larvæ or pupæ after death. The symptoms of European foulbrood vary greatly (see Farmers' Bulletin 975), while in American foulbrood they are much more definite. Diagnosis by bacteriological methods is less necessary for American foulbrood than for European foulbrood, but any doubtful samples should be sent to the Bureau of Entomology for diagnosis.[3]

In regions where both diseases occur, beekeepers at times experience difficulty in distinguishing them, owing chiefly to insufficient observation of the symptoms. If European foulbrood appears in an apiary in the spring, and if American foulbrood is observed later, the beekeeper may erroneously conclude that both types are manifestations of one disease, or that European foulbrood changes to American foulbrood. Such is not the case. It is therefore essential that the symptoms be studied with great care, since to treat American foulbrood by methods applicable only to European foulbrood will result in the spread rather than the eradication of the disease.

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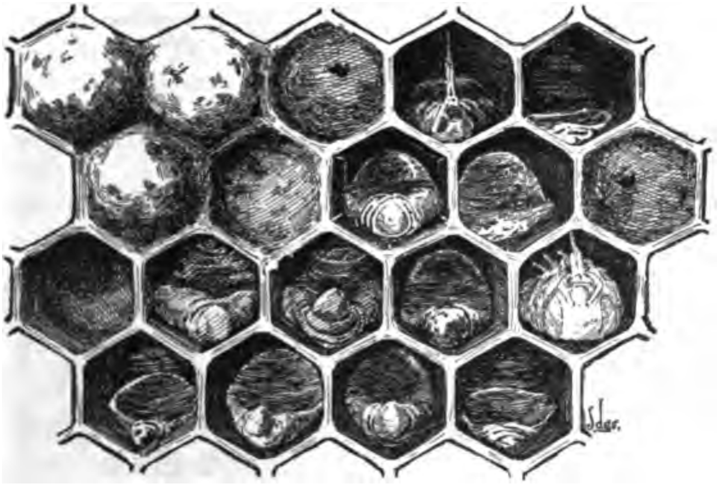
[1] Phillips, E. F. The brood diseases of bees. United States Department of Agriculture, Bureau of Entomology, Circular 79. 5 p., 1906.

[3] If dead brood is observed and the beekeeper is not able to diagnose it with accuracy, samples may be sent the Bureau of Entomology for examination. A piece of comb containing dead larvæ, about 4 by 5 inches, should be cut out and mailed in a heavy pasteboard or wooden box. Tin boxes should never be used, as the brood usually molds in transit, making examination impossible. The sample should not be wrapped before being placed in the box. A suitable box for sending samples will be mailed on request.

It is not possible to diagnose from empty combs, and no honey should be included in the sample, as it is valueless in diagnosis and will probably spoil the sample as well as other mail matter. The name of the sender must always appear on the package, and any available data should be sent in a letter. Never inclose a letter in the box with the sample.

American foulbrood is frequently called simply "foul brood." Usually it shows itself in the larva just about the time that the larva fills the cell and after it has ceased feeding and has begun pupation. At this time it is sealed over in the comb (fig. 1, *a*, *b*, *f*). The first indication of the infection is a slight brownish discoloration and the loss of the well-rounded appearance of the normal larva (fig. 1, *l*). At this stage the disease usually is not recognized by the beekeeper. The larva gradually sinks down in the cell and becomes darker in color (fig. 1, *h*, *m*), and the posterior end lies against the bottom of the cell. Frequently the segmentation of the larva is clearly marked. By the time it has partially dried down and has become quite dark brown (coffee colored) the most typical characteristic of this disease manifests itself. If a match stick or toothpick is inserted into the decaying mass and withdrawn, the larval remains adhere to it and are drawn out in a thread (fig. 2), which sometimes extends for several inches before breaking. This ropiness is the chief characteristic used by the beekeeper in diagnosing this disease. The larva continues to dry down and gradually loses its ropiness until it finally becomes merely a scale on the lower side wall and base of the cell (fig. 1, *e*, *p*, *s*). The scale formed by the dried-down larva adheres tightly to the cell and can be removed with difficulty from the cell wall. The scales can be best observed when the comb is held with the top inclined toward the observer so that a bright light



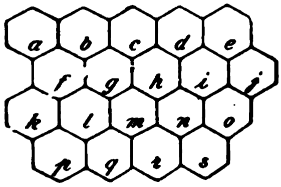


FIG. 1.—American foulbrood: *a*, *b*, *f*, Normal sealed cells; *c*, *j*, sunken cappings, showing perforations; *g*, sunken capping not perforated; *h*, *l*, *m*, *n*, *q*, *r*, larvæ affected by disease; *e*, *i*, *p*, *s*, scales formed from dried-down larvæ; *d*, *o*, pupæ affected by disease. Three times natural size.

strikes the lower side wall (fig. 3). A very characteristic and usually penetrating odor is often noticeable in the decaying larvæ. This, perhaps, can best be likened to the odor of heated glue.

The majority of the larvæ which die of this disease are attacked after being sealed in the cells. The cappings are often entirely removed by the bees, but when they are left they usually become sunken (fig. 1, *g*, *c*, *j*) and frequently perforated (fig. 1, *c*. *j*). As the healthy brood emerges, the comb shows the scattered sunken cappings covering dead larvæ (fig. 3), giving it a characteristic appearance.

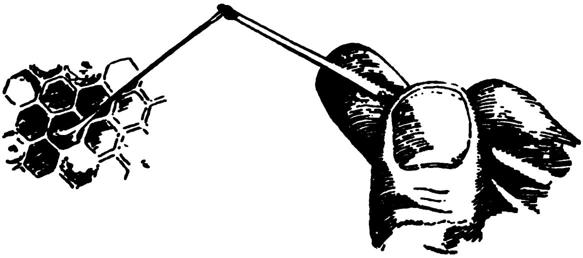


FIG. 2.—The ropiness of American foulbrood.

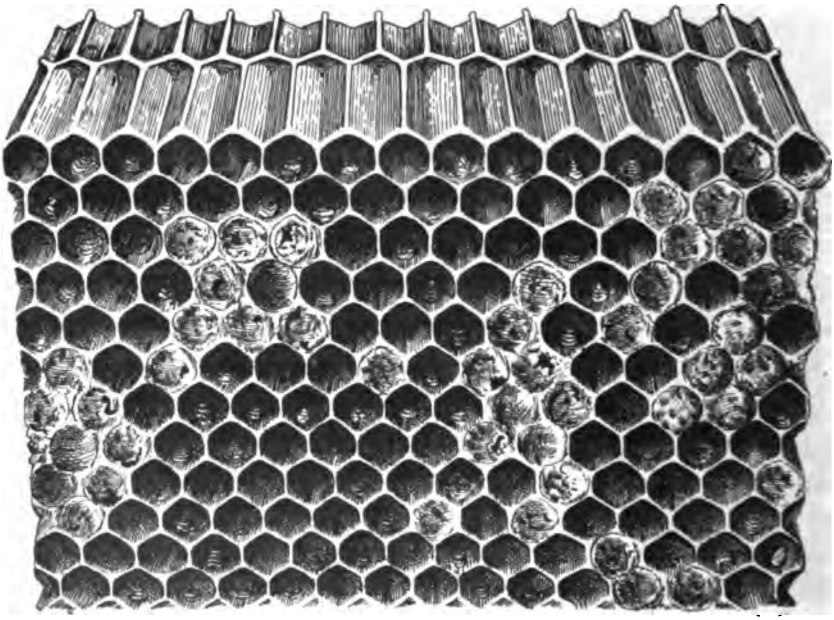


FIG. 3.—American foulbrood comb, showing irregular patches of sunken cappings and scales. The position of the comb indicates the best way to view the scales.

Pupæ also may die of this disease, in which case they, too, dry down (fig. 1, *o*, *d*), become ropy, and have the characteristic odor and color. The tongue frequently adheres to the upper side wall and often remains there even after the pupa has dried down to a scale.

Younger unsealed larvæ are sometimes affected. Usually the disease attacks only worker brood, but rare cases are found in which queen and drone brood are diseased.

BASIS OF TREATMENT.

The treatment of American foulbrood is based on certain definite observations concerning the nature of the disease and of the larvæ which die from it. The treatment was discovered long before the cause of the disease was suspected, but later work on the organism responsible for the disease has helped to explain the reasons for the treatment. For comparisons between the two diseases, the beekeeper should consult Farmers' Bulletin 975.

1. American foulbrood attacks colonies of all strengths and at any season of the year when the bees are active. In these respects it differs materially from European foulbrood. More samples of American foulbrood are received by the Bureau of Entomology during the season of the year when the beekeepers are working with their bees; that is, at times when they could best find it, than at other seasons. Samples, however, have been received during all months of the year, even in winter.

2. The disease does not disappear of its own accord. There may be cases in which a few cells in a colony are attacked by the disease and are cleaned out, but this is certainly a rare occurrence, and in general it may be stated that when the disease once enters the hive it will remain until the colony is destroyed, or until the disease is eradicated by the treatment given by the beekeeper.

3. The honey flow seems to have little effect on the course of the disease. When there is honey coming to the hive freely the bees generally rear brood more freely than during the seasons of dearth, and under such circumstances there is more material available for the development of American foulbrood. The disease, therefore, appears to spread more rapidly in the colony during a honey flow. During a heavy honey flow, when the larval food is made of fresh nectar in place of the old infested honey, the disease may appear to be less prevalent in the colony and may become less evident. On the other hand, during periods of dearth there is more likelihood that the bees will rob out colonies that have died of the disease, and it therefore appears in new colonies more rapidly when there is no honey flow.

4. All races and strains of bees are attacked by the disease. Italian bees are more vigorous and are better workers than the common German bees which were first brought to America. The German or black bees have so many bad qualities and so few good ones that the better beekeepers of the country are united in preferring the

Italian bees. In spite of their greater tendency to go out after honey from colonies that have died out, they are so much better that no beekeeper can afford to abandon Italian bees on this account.

5. American foulbrood is an infectious disease, caused by an organism known as *Bacillus larvae.* It was shown clearly by the experience of beekeepers before the disease was investigated from the bacteriological standpoint that it was infectious, and these investigations have supported the observations made by the beekeeper. The bacteriological work has shown further that the disease is caused by an organism that has never been found in any other brood disease of bees, and it is, therefore, a specific organism and American foulbrood is entirely distinct from European foulbrood or any other disease of bees. This is an important point, for there has been considerable confusion in the past in that a few beekeepers have claimed that one disease changes to the other. It should be stated that this supposition is not supported by any careful observations in the apiary, but it was recognized generally before the bacteriological investigations were made that the diseases are distinct.

6. The organism causing American foulbrood has been shown by the experience of beekeepers to be difficult to kill. It has long been known that it is not killed by any degree of cold ever encountered in the apiary, and it has also been known that long boiling is needed to make honey from a diseased colony safe for feeding to bees. These facts have been further confirmed by bacteriological observations, it having been shown that *Bacillus larvae* is a spore-bearing organism.

7. When a bee larva dies of American foulbrood the decaying mass adheres closely to the cell wall during practically all except the very earliest stages of decay, and also when it has dried down to a scale on the lower side wall of the cell. The bees are unable to remove all the scales, even under the most favorable conditions for house cleaning, although they may sometimes gnaw down a few cells and thus remove the scales.

8. The disease is spread from colony to colony through honey which becomes infected through being stored while the disease is in the hive. This is usually obtained by bees which go to rob hives in which the colonies are either weak or have died from the disease or from some other cause. The disease is frequently introduced to the apiary by the bees getting honey which has been shipped from an apiary containing American foulbrood. It is well known that this disease is present about most of the chief honey markets of the country, presumably introduced through honey shipped in to these centers.

9. It has been found necessary to disinfect honey from diseased colonies by boiling before feeding it to other colonies. This shows,

as indicated in the previous paragraph, that the organism is in the honey.

10. The disease as a rule does not spread through the apiary as rapidly as does European foulbrood. It is a malignant disease in that when a colony once becomes diseased it is doomed in time unless the beekeeper treats it by the methods herein described.

These facts have been discovered in the apiary rather than in the laboratory. They are supported by repeated observations, and while the records of observations are not as accurately made as are those of the laboratory, the correctness of most of the facts is attested by the experience of thousands of beekeepers. In certain cases, above mentioned, the observations have been corroborated by bacteriological findings.[1] The methods of treatment have all been devised in the apiary.

PREVENTIVE MEASURES.

No system of management of the apiary has yet been found which will prevent the entrance of American foulbrood. In this respect the disease differs greatly from European foulbrood. By observing the following precautions, however, the beekeeper frequently can prevent the bees from getting the honey from colonies which have the disease.

1. If a colony becomes weak from any cause, or if disease is suspected, contract the entrance to prevent robbing, and if robbing is imminent close the entrance entirely.

2. *Never feed honey purchased on the open market.* In case of doubt as to the source of honey, feed sugar sirup.

3. If within the range of possibility, see that no honey that comes from diseased apiaries is sold in the neighborhood. This may sometimes be accomplished by cultivating the home market so that there will be no incentive for bringing in other honey.

4. In introducing purchased queens, transfer them to clean cages provided with candy known to be free from contamination, and destroy the old cage, candy, and accompanying workers. Of course, if it is certain that the queen comes from a healthy apiary this is not necessary. The postal regulations now require that queen cages sent by mail either be provisioned with candy that will not transmit American foulbrood or that they be accompanied by a certificate from the apiary inspector that no disease has been found in the apiary.

5. Colonies of bees should never be purchased unless it is certain that they are free from disease.

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[1] Bacteriological studies of bee diseases have been useful to practical beekeepers in explaining the reasons for success or failure with various treatments attempted. These studies have been especially important, however, because through them methods of laboratory diagnosis of the different diseases have been worked out.

6. The purchase of old combs, second-hand supplies, or second-hand honey cans is dangerous, unless it is certain that they have come from healthy apiaries.

REMEDIAL MEASURES.

The treatment of American foulbrood consists primarily in the elimination or removal of the cause of the disease. It is definitely known that American foulbrood is caused by a bacillus named *Bacillus larvae.* In treating this disease, therefore, the aim of the manipulation is to remove or destroy all of the bacteria of this species. It should be remembered that the effort is not to save the larvæ that are already dead or dying, but to stop the further devastation of the disease by removing all material capable of transmitting the cause of the trouble.

In all of the operations great pains should be taken not to spread the disease through carelessness. After handling a diseased colony the hands of the operator should be washed with water to remove any honey that may be on them. It does not pay to treat colonies that are considerably weakened by disease. In case there are several such colonies they should be united before or during treatment, to form strong, vigorous, colonies.

In discussing treatment it is assumed that hives with movable frames are in use. Box-hives are a menace in regions where disease is present. These may be treated for disease by drumming the colony into another box and then hiving it like a swarm in a hive, but box-hives are not profitable and where disease is present are especially to be condemned on account of the difficulty of inspecting and treating them.

SHAKING TREATMENT.

The shaking treatment consists essentially in the removal of all infected material from the colony, and in compelling the colony to take a fresh start by building new combs and gathering fresh stores. This is done by shaking the bees from the old combs into a clean hive on clean frames.

Time of treatment.—The shaking treatment should be given during a flow of honey, so that other bees in the apiary will not be inclined to rob. If this is not possible the operation may be performed under a tent made of mosquito netting. The best time is during the middle of a clear day when a large number of bees are in the field. It is sometimes recommended that shaking be done in the evening, but this is impossible if many colonies are to be treated. The colony can be handled more quickly when the field force is out of the hive.

Preparation.—All implements that will be needed, such as queen and drone trap, hive-tool, and lighted smoker, should be in readiness before the operation is begun. A complete clean hive with frames is provided, as well as a tightly closed hive body in which to put the contaminated combs after shaking. An extra hive cover or some similar apparatus should be provided to serve as a runway for the bees as they enter the new hive. The new frames should contain strips of comb foundation from one-fourth to 1 inch wide. Full sheets are not desirable (when the bees are shaken only once), and if combs built on full sheets of foundation are desired they may be built later.

Operation.—The old hive containing the diseased colony (fig. 4, *A*) is now lifted to one side out of the flight of returning field bees and the clean hive (*B*) set exactly in its place. The cover (*G*) is now taken off and a few frames (*E*) removed from the center of the hive. If unspaced frames are used, those remaining in the hive should be pushed tightly to either side of the hive, thus making a barrier beyond which the bees can not crawl as they move to the top of the hive after shaking. This largely prevents them from getting on the outside of the hive. If self-spacing frames are used, a couple of thin boards laid on the top bars on either side will accomplish the same result. The runway (*D*) is put in place in front of the entrance. The old hive is now opened for the first time. The frames are removed one at a time, lowered part way into the new hive, and with a quick downward shake the bees are dislodged. The frames are then put into the extra hive body (*C*) and immediately covered to prevent robbing. After all the frames are shaken the bees remaining on the sides of the old hive (*A*) are shaken out.

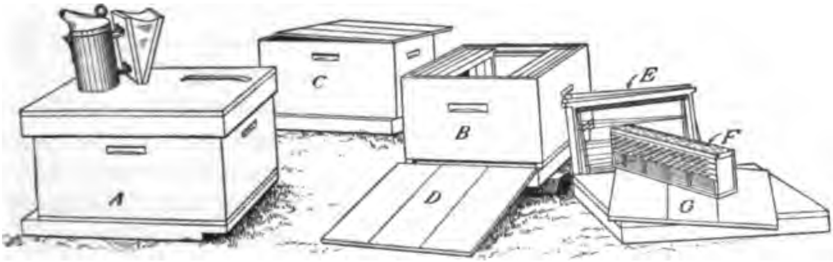

Fig. 4.—Apparatus for the shaking treatment: *A*, Hive containing diseased colony (formerly in position of *B*); *B*, clean hive; *C*, empty hive to receive combs after shaking; *D*, hive cover used as runway; *E*, frames removed from *B* to give room for shaking; *F*, queen and drone trap; *G*, cover for clean hive, *B*.

If honey is coming in freely, so that thin honey is shaken out of the combs, cover the runway (*D*) with newspapers and shake the bees in front of the new hive (*B*), leaving all frames in place and the cover on. After the operation the soiled newspapers should be destroyed. In shaking in front of the entrance the first one or two frames should be so shaken that the bees are thrown against the entrance, where they can locate the hive quickly. They then fan their wings and the others follow them into the hive. If this is not done the bees may wander about and get under the hive or in some other undesirable place.

After the bees are mostly in the new hive a queen and drone trap (*F*) or a strip of perforated zinc is placed over the entrance to prevent the colony from deserting the hive. The queen can not pass through the openings in the perforated zinc and the workers will not leave without her. The queen may also be placed in a queen cage for a couple of days, until the bees have built enough comb for her to use in laying eggs, after which there will be little chance that the bees will desert the hive. In place of the queen and drone trap or the strip of perforated zinc at the entrance, a queen-excluding honey-board may be placed under the hive but above the bottom-board. By the time that new combs are built and new brood is ready to be fed, any contaminated honey carried by the bees into their new hive will have been consumed and the disease will rarely reappear. If it should, a repetition of the treatment will be necessary.

Saving the healthy brood.—The old combs are now quickly removed. If several colonies are being treated at one time it may pay to stack several hive bodies containing contaminated combs over a weak diseased colony to allow most of the healthy brood to emerge, thereby strengthening the weak colony. After 10 or 12 days this colony is treated in turn and all the combs rendered into wax. If only one or two colonies in a large apiary are being treated it will not pay to do this.

Melting the extracting combs.—Since the extracting combs have not contained any of the diseased larvæ, many beekeepers ask whether it is necessary that these be melted up, or whether it is safe to use them over other colonies. In some cases such combs may be used, as in colonies where there is only a little of the diseased material or where no honey has been coming to the hive since the disease was contracted. The saving of such combs, however, is extremely dangerous, and such a policy is not to be advised. The beekeeper who takes all the precautions which it is possible to take is the one who most quickly and cheaply eradicates American foulbrood from his apiary.

Saving the wax.—Any but a very small apiary should have included in its equipment a wax press for removing wax from old combs. If contaminated combs are not to be rendered into wax they should be burned immediately. After the contaminated combs are taken to the honey-house they should be kept carefully covered, so that no bees can reach them until the wax can be rendered. It is not safe to store such combs in hive bodies except in a securely screened honey-house, and even then they should be well covered. The wax rendering should not be delayed very long or the combs may be ruined by wax moths. The slumgum or refuse remaining after the wax is removed should be burned. Contaminated combs should not be put into a solar wax-extractor for fear of spreading the disease. The wax from contaminated combs may be used safely for the manufacture of comb foundation.

Cleaning the hive.—The hive which has contained the diseased colony should be thoroughly cleaned of all wax and honey, and it is desirable that it be carefully disinfected by burning out the inside with a gasoline blue-flame torch (fig. 5). If this piece of apparatus is not available several hive bodies may be piled together on a hive bottom and some gasoline or kerosene poured on the sides and on some straw or excelsior at the bottom. This is then ignited and after it has been burning for a few seconds a close-fitting hive cover is placed on top of the pile to extinguish the flames. The inside of the hive bodies should be charred to a light brown. The careful cleaning and disinfection of frames always costs considerably more in labor than new frames would cost, but they may be used again if carefully cleaned. Frames may be cleaned by boiling in water for about half an hour, but this frequently causes them to warp badly, and it is a better plan to dip them into boiling lye water which will immediately clean off wax and propolis. The disinfection of hives and frames with chemicals is not recommended, as the ordinary strengths used are valueless for the purpose.

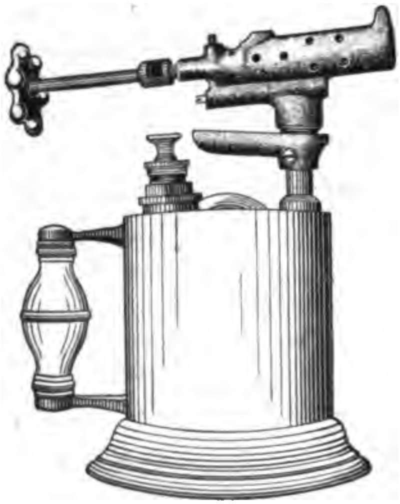

FIG. 5.—Gasoline torch.

Disposal of the honey.—If there is a considerable quantity of honey in the contaminated combs it may be extracted. This honey can not be safely fed to bees without boiling, but it is absolutely safe for human consumption. If there is a comparatively small quantity it may be consumed in the beekeeper's family, care being taken that none of it is ever placed where the bees can get it.

To put such honey on the market is contrary to law in some States. There is always danger that an emptied receptacle will be thrown out where bees can have access to it, thus causing a new outbreak of disease. It can be safely used for feeding to bees, provided it is diluted with at least an equal volume of water to prevent burning, and boiled in a closed vessel for not less than one-half hour, counting from the time that the diluted honey first boils vigorously. The honey will not be sterilized if it is heated in a vessel set inside of another containing boiling water. Boiled honey can not be sold as honey. It is good only as a food for bees, and even then should never be used for winter stores, as it probably will cause dysentery.

The second shake.—Some beekeepers prefer to shake the bees first onto frames containing strips of foundation as above described, and in four days to shake the colony a second time onto full sheets of foundation, destroying all comb built after the first treatment. This insures better combs than the use of strips of foundation, but is a severe drain on the strength of the colony, and the bees are far more likely to desert the hive. Since it is desirable to have combs built on full sheets, the best policy is to replace any irregular combs with full sheets of foundation or good combs later in the season.

The cost of shaking.—If the treatment just described is given at the beginning of a good honey flow, it is practically equivalent to artificial swarming and results in an actual increase in the surplus honey, especially in the case of comb-honey production. The wax rendered from the combs will sell for enough to pay for the foundation used if full sheets of foundation are employed. Since a colony so treated actually appears to work with greater vigor than a colony not so manipulated, the cost of treatment is small. If treatment must be given at some other time, so that the colony must be fed, the cost is materially increased. In feeding, it is best to use sugar sirup, or honey that is known to have come from healthy colonies.

TREATMENT WITH FULL SHEETS OF FOUNDATION.

In order not to have any combs in the apiary built on strips of foundation, some beekeepers prefer to shake the bees into a hive containing full sheets of foundation. In the place of one of these frames there is put in the hive an old piece of comb—one that has been broken or which for some other reason will not further be useful. Into this comb the bees soon place the honey which they have carried over in their honey-stomachs, and the second morning after treatment the hive is carefully opened, with as little confusion as possible, and this old comb is removed. As little smoke as possible should be used in this operation and the comb should be taken out quickly in order that the bees may not again take up the honey before it is removed. In the place of the old comb there is inserted a new frame containing a full sheet of foundation and the treatment is complete. It will be fatal to success if the old comb is not removed, for then the disease will almost certainly reappear.

TREATMENT WITH BEE-ESCAPE.

As a substitute for the shaking treatment just described, the bees may be removed from their old combs by means of a bee-escape. The old hive is moved to one side and in its place is set a clean hive with clean frames and foundation. The queen is at once transferred to the new hive and the field bees fly there on their return from the field. The infected hive is now placed on top of or close beside the clean hive and a bee-escape placed over the entrance, so that the younger bees and those which later emerge from the cells can leave the contaminated hive but can not return and therefore will join the colony in the new hive. If desired, the infected hive may be placed above the clean hive and a tin tube about 1 inch in diameter placed from the old entrance so that the lower end is just above the open entrance of the new hive. The bees follow down this tube and on their return enter the new hive. When all of the healthy brood has emerged from the infected combs the old hive should be removed. This treatment induces less excitement in the apiary and is preferred by many experienced beekeepers. Care should be taken that the old hive is absolutely tight to prevent robbing. The old hive and its contents of honey and wax are treated as indicated under the shaking treatment.

FALL TREATMENT.

If it is necessary to treat a colony so late in the fall that it would be impossible for the bees to prepare for winter, the treatment may be modified by shaking the bees onto combs entirely full of honey so that there is no place for any brood to be reared. This usually will be satisfactory only after brood rearing has entirely ceased. Unless a colony is quite strong it does not pay to treat it in the fall, but it should be destroyed or united to another colony. In case a diseased colony dies outdoors in the winter there is danger that other bees may have opportunity to rob the hive before the beekeepers can close the entrance. If bees are wintered in the cellar it is more advisable to risk wintering before treatment, for if the colony does die the hive will not be robbed.

DRUGS.

Many European writers in the past have advocated the use of various drugs for feeding, in sugar sirup, to diseased colonies, or the fumigation of contaminated combs. In the case of American foulbrood it has been found that the drugs recommended are not of the slightest value and no time should be wasted in their use.

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UNITED STATES DEPARTMENT OF AGRICULTURE

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FARMERS' BULLETIN 1085

UNITED STATES DEPARTMENT OF AGRICULTURE

HOG-LICE AND HOG-MANGE

Methods of Control and Eradication

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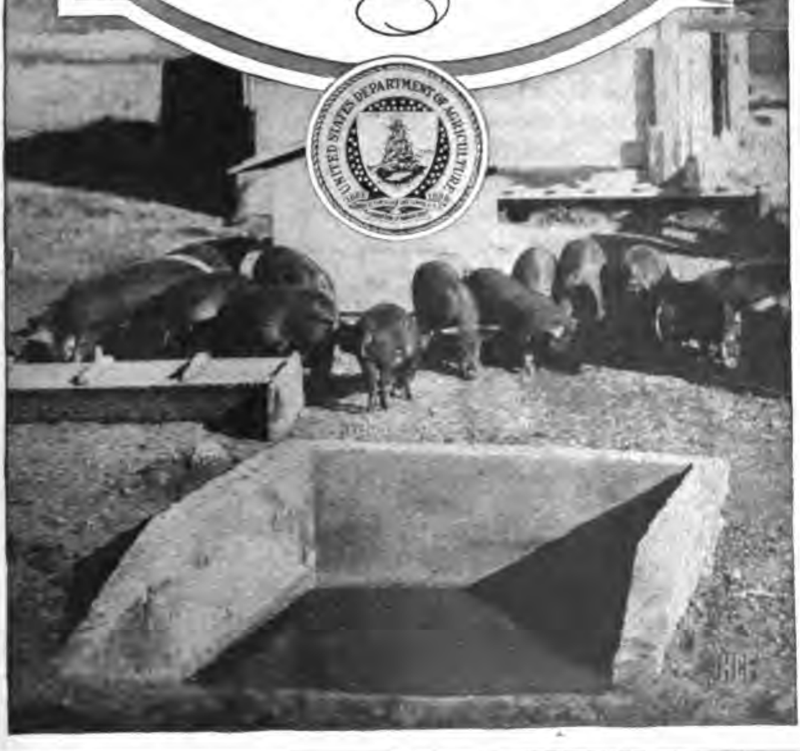

LICE AND MANGE mites are the two principal kinds of external parasites affecting hogs. They are injurious to all classes of hogs, but the greatest losses occur in pigs and poorly nourished hogs kept in insanitary quarters.

The losses are caused by irritation, unthrifty condition, functional disturbances, arrested growth, low vitality, and increased death rate.

Only one species of lice commonly affects hogs, and this parasite obtains its food by puncturing the skin of the host and sucking blood. It can be eradicated by hand applications, spraying, medicated hog wallows, and dipping. Dipping is the best method of applying treatment. Crude-petroleum and coal-tar-creosote dips are effective remedies.

Two species of mange mites commonly affect hogs. The nature and habits of these mites, the symptoms caused by each species, and the methods of control and eradication are discussed in this bulletin. Crude-petroleum and lime-sulphur dips are effective remedies for common or sarcoptic mange of hogs.

Plans of hog wallows and dipping plants, together with directions for building them and for dipping hogs, are given.

Contribution from the Bureau of Animal Industry
JOHN R. MOHLER, Chief
Washington, D. C. **Issued May, 1920**

HOG LICE AND HOG MANGE.

METHODS OF CONTROL AND ERADICATION.

Marion Imes, *Zoological Division.*

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HOG LICE.

DISTRIBUTION AND ECONOMIC IMPORTANCE.

Hog lice occur more or less frequently on both domesticated and wild hogs in practically all parts of the world. The parasites are prevalent in all parts of the United States where hogs are raised, and live-stock growers generally recognize them as a pest that causes considerable loss to the swine industry.

In obtaining their food the lice puncture the skin of the host animal and suck blood and lymph. A new puncture in the skin is made each time a louse feeds. A single puncture causes considerable irritation and itching, and as each louse feeds at frequent intervals, the irritation and itching is almost constant in cases of gross infestation. In an attempt to relieve the intense itching the infested animals scratch themselves with their feet and rub violently against any convenient object. The frequent rubbing destroys the hair in patches and often causes wounds in the skin. The lice congregate around the abrasions and thus cause further irritation and annoyance to the animals.

Lice may attack hogs of any age or condition, and if allowed to spread the infested animals suffer and the owner loses in the increased quantity of feed consumed per pound of gain, arrested growth of young pigs, and shrinkage in weight of fattening hogs. When young pigs become infested at an early age from the brood sow and the lice are allowed to remain on the animals until the hogs are ready for butchering, the loss caused by the parasites is a considerable item in the cost of producing pork. Estimates based on observations and limited experimental data fix the direct money loss in such cases at from 2 to 6 per cent of the market value of the hog. The indirect losses caused by lice are seldom taken into consideration, because on casual observation they are not so apparent. Hogs infested by large numbers of lice suffer a lowering of vitality and a generally unthrifty condition which renders them more susceptible to attack by other parasites and by contagious diseases. The damage and losses caused by hog lice are of sufficient importance to warrant the application of treatment for their eradication.

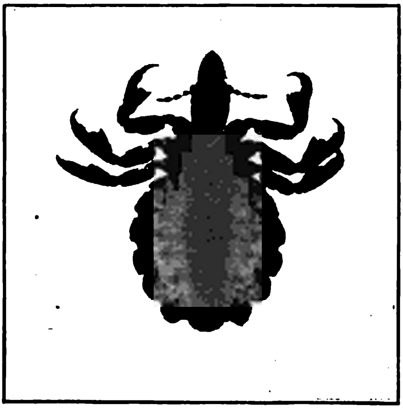


FIG. 1.—Male hog louse.

NATURE AND HABITS.

The hog louse, known technically as *Hæmatopinus suis*, is a blood sucking parasite and one of the largest of the lice affecting domestic animals. The full-grown female often attains a length of one-fourth of an inch. The male louse is slightly smaller and can be distinguished by a black streak on the underside of the abdomen along the middle of the last three segments. The feet are adapted for clasping the hairs, and the lice travel sidewise through the hair or bristles of the hog.

The entire life cycle is passed on the host. The females deposit and glue their eggs or "nits" on the hairs close to the skin. This may occur on any part of the body, but the favorite locations are the lower half of the sides, around the neck, shoulders, and flanks. The female lays from 3 to 6 eggs a day and the average length of the egg-laying period is about 25 days. The average number of eggs laid by the female louse during her lifetime is about 90. The eggs hatch on the host in from 12 to 20 days, the majority hatching in from 12 to 14 days. The young lice become active soon after hatching and seek the parts covered by tender skin for feeding. The favorite location for young lice, especially during cold weather, is the inside of the ear, where they often congregate

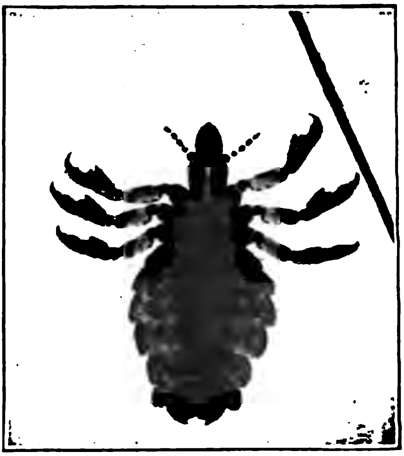


FIG. 2.—Female hog louse and egg attached to hair. (Photomicrograph by Dr. W. T. Huffman.)

in large clusters and where the skin is tender and they are protected from the cold and also from the efforts of the host to dislodge them. When a suitable place is found the young louse punctures the skin with its sharp mouth parts and sucks blood until satisfied.

Hog lice do not remain attached to the skin like ticks, but detach after each feeding and wander about through the hair or remain quiet, either singly or in groups. They feed at frequent intervals and develop rapidly. The young lice reach maturity and mating occurs when they are about 10 days old. The females begin laying eggs when they are about 12 days old and the average length of life is about 35 days.

Except in accidental cases, hog lice are found only on hogs, and they do not voluntarily leave their natural host. When separated from the animal they live only two or three days. The lice pass readily from one hog to another when the animals come in close contact. Practically all cases of infestation occur from contact with lousy animals and not from infected premises. Under reasonably good sanitary conditions pens, corrals, and premises which have contained lousy hogs are not a source of danger to hogs free from lice. As a precautionary measure, however, and because it is good sanitary practice, all small inclosures which have contained lousy hogs should be cleaned and disinfected before being used for a new lot of hogs. The litter and manure should be removed and the floors cleaned, after which the woodwork and floors should be sprayed with a good disinfectant. The coal-tar-creosote dips, diluted in accordance with instructions on the container, are suitable for this purpose.

HOG MANGE.

VARIETIES AND GENERAL CHARACTERISTICS.

Scabies in hogs, commonly known as mange, is a term applied to two contagious skin diseases caused by insectlike parasites known as "mites," which live in the skin. The two species of these parasites which affect hogs are classified in two different genera—*Sarcoptes* and *Demodex.*

Mange mites spend their entire life on the host animal. In obtaining their food from the tissues and blood of the affected animal the parasites cause wounds or lesions in the skin. As each kind of mite possesses distinctive habits in its manner of feeding and other activities, the nature and location of the lesions caused by them are more or less characteristic. The sarcoptic mites, which cause common hog mange, burrow into the skin, each female making a separate gallery in which she lays her eggs. The skin over and around the burrow or gallery becomes irritated and inflamed and a small cone-shaped swelling is formed. The demodectic mites, which cause demodectic or follicular mange, are very small and in appearance somewhat like microscopic worms. They live in colonies or groups in the hair follicles and sebaceous glands and cause small, spherical, hard swellings.

SARCOPTIC OR COMMON MANGE.

Sarcoptic or common mange occurs in hogs in the United States much more frequently than the follicular variety. Although the disease has not become highly prevalent in any one section, it seems to be increasing throughout the Corn-Belt States. Other sections of the country, even those parts of the West where a comparatively small number of hogs are raised, have more or less hog mange. Traffic in breeding stock evidently has been an important factor in spreading the disease. Like scab in other species of animals, hog mange spreads rapidly under favorable conditions unless active measures are taken for its control. Although pigs, young growing stock, and old, poorly nourished animals of low vitality suffer most from the ravages of mange, the disease often attacks vigorous, mature hogs and causes great losses. The losses are caused by irritation, arrested growth, unthrifty condition, decreased vitality, functional disturbances, and increased death rate. The disease, however, can be eradicated, and if proper methods are adopted before it becomes advanced the losses can be reduced to a minimum.

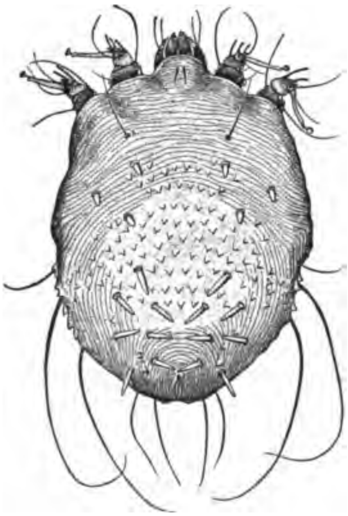


FIG. 3.—Sarcoptic mange mite. Female. Magnified 100 times.

THE SARCOPTIC MANGE MITE.

The mites which cause sarcoptic mange are small, whitish-colored parasites known technically as *Sarcoptes scabiei suis*. The mature female measures about one-fiftieth and the male about one-sixtieth of an inch in length. Although they are visible to the naked eye, particularly if placed on a dark background, it is advisable to use a low-power magnifying glass in examining scrapings or material suspected of containing the mites. The general form of the body is round and the bluntly rounded head is as broad as it is long. When mature these mites have four pairs of short, thick legs, the fourth pair and usually the third pair not extending beyond the margin of the body. A conspicuous feature under a high-power microscope is the presence of a considerable number of short, backward-projecting spines on the upper surface of the body.

The entire life cycle is passed on the body of the host animal. The mites penetrate through the upper layer of the skin and excavate burrows or galleries in which the eggs are laid. Each female may lay from 10 to 25 eggs during the egg-laying period, which probably lasts from 12 to 15 days, after which the female dies in her burrow. The eggs hatch in from 3 to 10 days and the young mites after passing through several molts reach maturity and begin laying eggs in 10 or 12 days. As the surface of the skin constantly is wearing away and being renewed from below, the young mites are close to the surface when they hatch out. They escape from their shallow burrows and form new ones in which they in turn deposit their eggs.

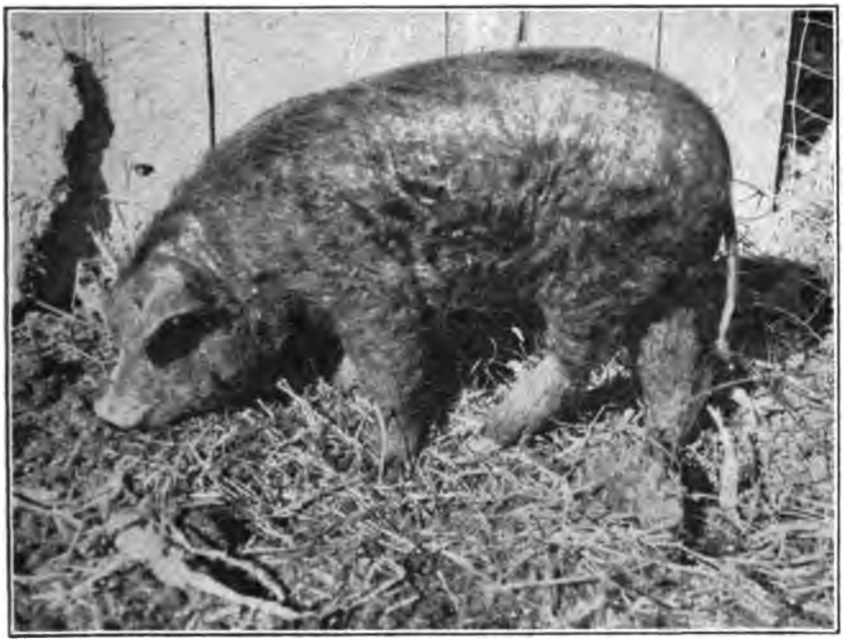


FIG. 4.—A case of hog mange in the early stages of the disease.

As the average period of incubation on the animal is about 4 days and the average period after hatching until egg laying begins is about 11 days, a new generation of mature mites may be produced about every 15 days.

SYMPTOMS OF COMMON MANGE.

Sarcoptic mange of hogs may start on any part of the body but in the early stages of the disease the lesions usually are found on the head, around the eyes, nose, or ears. From these parts it spreads over the neck and shoulders and along the back and sides, finally involving the entire body.

The parasites penetrate the upper layer of skin, each one forming a separate burrow or gallery in which it lives. The presence of the mites on the "quick" or sensitive tissues causes great irritation and the skin over and around each burrow becomes inflamed and swollen. These swollen areas are somewhat larger than pinheads and often have a yellowish-colored granule of dried serum adhering to them. As the mites multiply, the diseased area increases and the granular or raised areas become closer together. The hair over the affected part stands erect and some of it drops out or is rubbed off, though usually a few scattering hairs remain even in advanced cases. The affected areas of skin often take on a dry, scurfy, or leatherlike appearance, especially when the mites are not very active. Such cases are known as the dry form of mange, and in this form the rubbing of the animal often has a sort of polishing effect upon the dead scales of the skin and the dried serum, and the affected areas may have a dry, slightly glistening, silver-gray appearance.

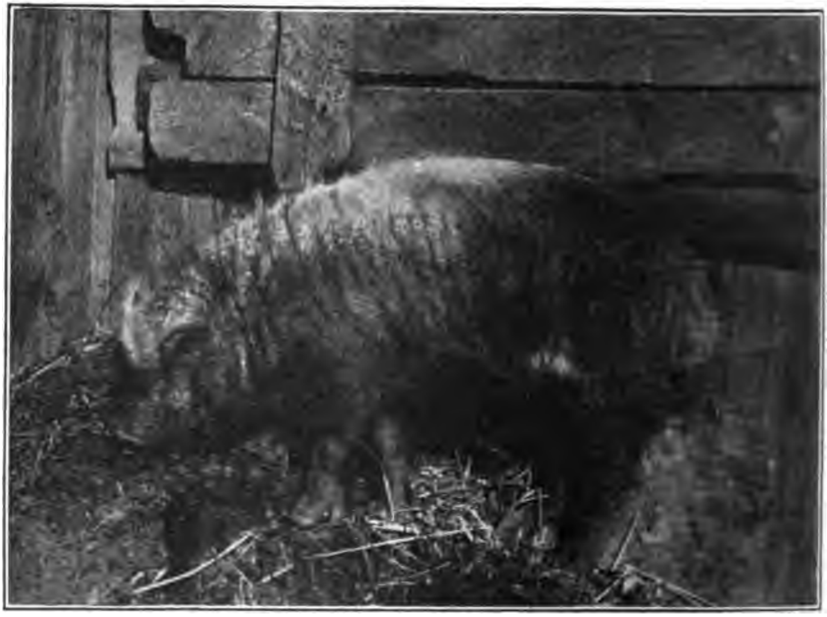


FIG. 5.—A case of advanced hog mange showing wrinkled condition of skin.

The intense itching causes the animal to scratch and rub the affected parts until the skin becomes raw. The mechanical injury thus caused results in a running together of the small granular areas and large scabs are formed. The large scabs, which are firmly attached to the underlying skin, often are broken by the movements of the animal and blood and serum ooze out of the cracks. The surface of the lesion may have a dry, pearl-gray appearance or it may be moist and stained a reddish yellow by blood and serum. In chronic cases the odor from the moist form sometimes is very offensive.

As the disease advances the skin becomes more or less bare and is hard, greatly thickened, and thrown into wrinkles or folds. The furrows formed by the wrinkles are thickly inhabited by mites and scrapings taken from the bottom of a fold usually contain the parasites in abundance. In severe cases the animals rapidly lose flesh, become emaciated and greatly weakened, and unless properly treated many of them will die.

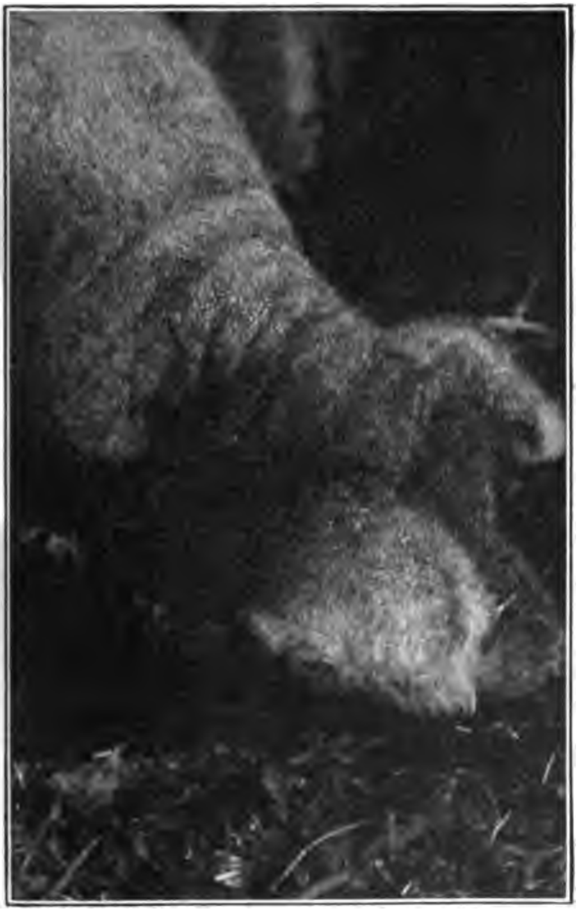


FIG. 6.—Advanced hog mange showing pedicel-like scabs.

The most certain diagnosis consists in finding the mites, which are the sole cause of the disease. On account of their burrowing habits the parasites often are difficult to find, especially in the early stages of the disease. By scraping the affected area with a blunt-edged knife until the blood flows and examining the scrapings in the warm sunshine or near artificial heat under a low-power magnifying glass the mites may be found. In doubtful cases the scrapings may be steeped in a 10 per cent solution of caustic potash and examined under a microscope.

CONTAGIOUSNESS OF COMMON MANGE.

Sarcoptic or common mange of hogs is contagious and is usually spread by direct contact with infected animals. The disease is readily transmissible to man and also from hogs to some other species of animals, but in such cases the mites generally live only a limited time on the new host. The disease may persist in man, however, for 30 days or longer and cause extreme annoyance. It is advisable, therefore, to bathe and change clothing as soon as possible after handling mangy hogs.

As the sarcoptic mites live in their burrows they do not spread to other animals so rapidly as those varieties which live solely on the surface of the skin, but on account of the hogs' habit of sleeping in close contact with one another the disease often makes great headway in herds confined in pens or stables. The infection spreads rapidly under various insanitary conditions, such as crowded or unclean quarters, exposure to cold, inclement weather, insufficient feed of poor quality, or any other circumstance tending to lessen the vitality or functional activities of the animals. The spread of the disease is not limited to any one season of the year, although healthy hogs seldom become infected during the summer months, especially if they have access to green succulent feed and are kept in open lots or fields where they are exposed to the sunshine.

Hogs of all classes, ages, and conditions are susceptible to sarcoptic mange, but usually the disease does not spread rapidly in well-fed, vigorous animals kept in sanitary quarters. The weak, unthrifty animals are the first to show lesions of the disease after exposure to the infection and the mites spread from them to other hogs with which they come into contact. Visible lesions of mange may develop in from 15 to 45 days after exposure, or a much longer time may elapse before the exposed hogs show indications of infection. Cases of mange may become generalized in 6 weeks, or a much longer time may elapse before the lesions spread to any great extent.

One or more attacks of the disease do not confer immunity, and after the disease has been cured the animals may become reinfected by contact with infected hogs or possibly by confinement in small inclosures in which mangy hogs have recently been kept. While practically all cases of hog mange seem to originate from contact with infected animals, the possibility of animals becoming infected from infected premises should not be overlooked. Although the mite will not reproduce itself except on the bodies of animals, it is able to live for two or three weeks when removed from hogs, and under favorable conditions may live much longer. Dislodged eggs which drop in moist, protected places may retain their vitality for from two to four weeks during mild weather. In dry places exposed to bright sunshine the mites and eggs are destroyed in a few days.

While the results of a large number of experiments indicate that hogs do not contract mange from infected premises, nevertheless, in actual practice, cases occur which seemingly can be explained on no other ground. It is advisable, therefore, to clean and disinfect all hog houses, pens, sheds, or small inclosures in which mangy hogs have been confined before using them for healthy hogs. Remove all litter and manure, cleaning down to a smooth surface, then spray all walls, woodwork, and floors with a good disinfectant. The coal-tar-creosote dips and disinfectants diluted in accordance with instructions on the containers are suitable for this purpose. The manure or litter from infected pens or buildings should be spread on the ground and plowed under or disposed of in such manner that hogs can not come into contact with it, and all troughs and implements used in the infected inclosures should be immersed or washed in the disinfectant.

DEMODECTIC (FOLLICULAR) MANGE.

Demodectic or follicular mange of hogs is caused by minute wormlike mites known technically as *Demodex phylloides* or *Demodex folliculorum suis*. Similar follicle mites occur in dogs, cattle, and other animals, and also in man. The parasites are truly microscopic in size, the full-grown female measuring approximately one one-hundredth of an inch in length. They penetrate into the hair follicles and sebaceous glands of the skin, where the entire life cycle is completed. When present in small numbers they apparently cause the animal no serious inconvenience, but occasionally they increase rapidly and cause well-marked lesions in the skin of the affected animal. The disease is contagious to all classes of hogs.

The lesions usually appear first on the snout or around the eyelids and spread slowly from these parts over the underside of the neck, breast, abdomen, inner sides of the hind legs, and other parts of the body where the skin is thin and tender. The back and upper part of the sides where the skin is thick and tough usually are not affected. In the early stages of the disease the affected skin may be red and scurfy, and small, hard, nodular lumps ranging in size from that of a pinhead to that of a hazelnut appear in the skin. The nodules may be dark red or they may be light red with a whitish or cream-colored center. As the disease advances the nodules break and discharge a creamlike pus or lumps of matter of a cheeselike consistence. Two or more of the nodules may break and run together, forming suppurating cavities.

There is no known specific cure for demodectic mange, although frequent dippings in crude petroleum check the progress of the disease and heal many of the old lesions. Herds in which demodectic mange appears should be dipped in or treated with crude petroleum, and any animals having advanced cases which do not respond to treatment should be killed. The remainder of the herd should be fattened for market and disposed of and the premises cleaned and disinfected before being restocked with healthy hogs. The cleaning and disinfecting of premises occupied by hogs infected with follicular mange should be performed in the same manner as for sarcoptic mange.

TREATMENT FOR LICE AND MANGE.

The five commonly used methods of applying treatment for external parasites of hogs are (1) hand applications, (2) spraying, (3) hog oilers, (4) medicated wallows, and (5) dipping. The best method to adopt naturally depends upon the number of hogs to be treated, the season of the year, the remedies selected, and the facilities available. While both mange and lice can be eradicated by proper hand applications, this method of applying treatment is practicable only when a few hogs are to be treated.

If no dipping vats or wallows are available or if the weather is too cold for dipping, hand applications are beneficial in checking the spread of lice or mange until the weather is suitable and arrangements can be made for dipping. Treatment of hogs in a dipping vat or in medicated wallows during the mild weather of autumn is a good insurance against the risk of loss from mange and lice and the probable additional expense of winter treatment. In applying treatment for either mange or lice the entire herd should be treated whether all the animals show infection or not.

HAND APPLICATIONS.

On account of the difficulty of restraining hogs and of covering the entire surface of the body by hand applications, this method of applying treatment should be used only as a temporary makeshift until the animals can be dipped or treated in wallows. The following remedies, when applied by hand, have proved to be effective for lice and mange: (1) Crude petroleum, (2) cottonseed oil and kerosene, equal parts, and (3) kerosene and lard mixed in the proportion of one-half pint kerosene to 1 pound of lard. These remedies may be applied with a brush, mop, or cloth and they should be distributed in a thin, even coating over the entire surface of the head and body, including the inner surfaces of the ears and between the thighs. When treatment is being applied for mange special care should be taken to see that all spots of scab are well coated. Freshly oiled or greased hogs should not be moved rapidly, exposed to bright sunshine, or allowed to become chilled, as injury to the animals may result.

Crude petroleum is the most effective known remedy for lice and mange and on account of its spreading, adhesive, and protective qualities it is the most suitable for use in hand applications. It may be applied with a can having a flattened spout or from an ordinary sprinkling can having large holes in the sprinkler. The practice of throwing feed on the ground and sprinkling oil on the hogs while they are eating is not recommended, because more or less of the oil falls on the feed and is consumed by the animals. A better method is to restrain the hogs during the application of the oil by crowding them in small pens or inclosures. When the oil is applied by sprinkling or pouring, it usually does not reach the inner surface of the ears, which should be given supplementary treatment with a swab that has been dipped in the oil.

SPRAYING.

Spraying is not so economical or effective as dipping because of the difficulty of thoroughly wetting hogs with a spray from an ordinary spray nozzle. Much of the dip runs off and is wasted, and unless plenty of it is used and the spraying is continued until all parts are well soaked the treatment will not be effective. Mange and lice can be eradicated by spraying, however, if the work is done properly. An ordinary hand spray pump is suitable for the purpose, or where an orchard-spraying outfit is available it may be used. Any of the dips recommended for scab may be applied in the form of a spray and the interval between sprayings should be the same as those between dippings.

HOG OILERS.

Hog oilers or rubbing posts are devices so arranged that when a hog rubs against them a small quantity of oil is deposited on or near the spot of skin being rubbed. They may be divided into two general classes: (1) Homemade rubbing posts and (2) the patented hog oilers. The first usually consists of a post set firmly in the ground and wrapped securely with gunny sack or rope that is kept saturated with oil. The oil is poured over the post covering from time to time or a can of oil is fastened to the top of the post and the rope or gunny sack is kept saturated by fastening the upper end in the vessel of oil. There are various types of patented hog oilers on the market and many hog growers in the Corn-Belt States have one or more of them in their hog lots.

When a hog desires to rub itself it does not go to a rubbing post or hog oiler unless it happens to be close to one, but it rubs against the first convenient object it finds. At best only a limited area of skin is covered with oil when a hog rubs against an oiler; consequently the various oiling devices are not successful in eradicating external parasites. When the oil containers are kept supplied with oil and the machine not allowed to become clogged with mud, the use of hog oilers tends to lessen the spread of lice and mange, but they should not be depended upon to effect eradication or even to prevent the losses caused by gross infestation of mange mites or lice.

MEDICATED HOG WALLOWS.

The instinctive habit of the hog to wallow in water when the weather is warm may be taken advantage of in applying treatment for external parasites. By medicating the water in properly constructed wallows remedies for lice and mange may be applied in a satisfactory manner with a minimum expenditure of money, time, and labor. If the results from the use of medicated wallows are to be satisfactory, however, it is necessary to consider the nature and habits of the animals to be treated and plan accordingly.

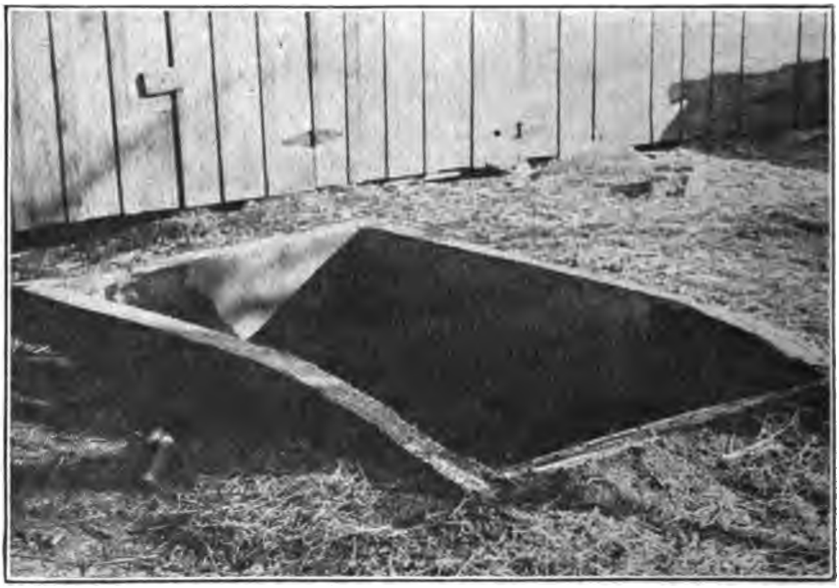


FIG. 7.—Hog wallow of concrete.

If conditions are such that hogs may exercise choice in the matter, they invariably select shallow water in which to wallow. When a hog wades into water it apparently tries to measure the depth and learn the nature of the bottom by submerging its nose and face, and if the water is too deep the animal may squat on its haunches or assume a recumbent attitude, resting on its chest and abdomen with the legs folded under and the head elevated, but it does not lie down on its side. If the water is sufficiently shallow so that the nostrils can be kept above the surface of the liquid easily the hog lies down on its side and rolls and then gets up and repeats the operation on the other side until the entire surface of the body is wet. As a volume of liquid is displaced when a hog lies down in the wallow the water line is raised accordingly and the greater the number of hogs lying in the wallow at one time the higher the water line is raised. The proper depth of liquid in the wallow, therefore, depends upon the size and number of hogs using the wallow.

For pigs weighing from 40 to 80 pounds the wallow should be charged with liquid to a depth of about 3 inches. For hogs weighing from 80 to 150 pounds about 4 inches of liquid is sufficient. The depth may be increased to 5 or 6 inches for heavier hogs, but the medicated liquid in the wallow should never be so deep that the hogs are afraid to lie down and wallow in it. When only one wallow is available for a mixed lot of hogs of various sizes from 3 to 4 inches of liquid will give better results than a greater depth. The water should always be shallow and no medicine added until the hogs have become well accustomed to using the wallow. After the habit of using the wallow is well fixed, which usually requires 3 or 4 days, the depth may be increased if necessary and the medicaments added.

The wallow should not be kept medicated continuously, as the medicament when applied too often is liable to cause irritation and the hogs may refuse to use the wallow after a few days. In from 24 to 48 hours after the liquid in the wallow has been medicated all hogs probably will be well soaked and the wallow should be drained and cleaned and recharged with water only. Medicaments may be added every week or ten days until the desired results are obtained.

Hogs are liable to drink from the wallows unless the water is denatured by some substance distasteful to them. Because of its denaturing qualities, its tendency to spread over the surface of the body, and its effectiveness as a remedy for external parasites, crude petroleum is the most suitable dip for use in hog wallows. In using it in wallows add about 1 pint for each pig and about 1 quart for each hog. Observe whether all the animals use the wallow and whether their bodies are well coated with the oil. If all are not well coated add more oil to the wallow.

The oil floating on the surface of the water limits or prevents evaporation and if the wallow is exposed to the direct rays of the sun during the hot summer months the water becomes heated to such a degree that the hogs will not lie in it. It is advisable, therefore, to construct a shade over the wallow or to add the oil in the evening. Oil added after sundown usually is carried out on the bodies of the hogs before noon of the next day.

A shady, well-ventilated place should be provided for freshly oiled hogs. All wallows should be drained and cleaned as often as necessary to keep them and the surroundings in good sanitary condition.

DIPPING.

Dipping consists in immersing animals in a medicated liquid that will kill the parasites. It is the most effective known method of applying treatment. Dipping plants are usually arranged so that the hogs enter one end of the vat filled with dip, swim through, and leave the vat at the opposite end. During dipping, the liquid in the vat should be from 40 to 48 inches deep, which is sufficient to swim the tallest animal. The quantity of dip necessary to complete the work should be ascertained and materials sufficient to make that quantity provided before the work of preparing the dip is begun. The average 100-pound hog will carry out and retain from 1 to 1½ pints of dipping solution and full-grown hogs will retain about 1 quart. The total estimated quantity of dip which the animals carry out and retain plus what is required to charge the vat should equal the total quantity required to complete the work if none is lost by leakage or otherwise.

The capacity of the vat is usually calculated in the following manner: Multiply the average length in inches by the average width in inches, then the product by the depth in inches; this will give approximately the number of cubic inches of space to be filled with dip. Divide this by 231 (the number of cubic inches in a gallon), and the result will be approximately the number of gallons of dip required to charge the vat. To obtain the average length add the length at the bottom to the length at the top (that is, at the line to which the vat is to be filled), and divide the sum by 2. Obtain the average width in the same manner. The depth should be taken at the middle of the vat, and should be from the bottom to dip line only and not to the top of the vat. Likewise, in determining the length and width, measure only the space to be filled with liquid and not above that line. The capacities of any tanks that are used are obtained by a like process. Gauges or rods should be prepared and marked to show the number of gallons at various depths in the vat and tanks.

After the vat is filled to the required depth with any of the dips except oil, the contents should be mixed well by stirring, in order that the dip may be of uniform strength and temperature throughout. A good method of stirring the dip is to take a pail or empty dip container in which a wire bail has been fastened, attach a rope or dipping fork to the bail, allow the vessel to fill and partially sink, then drag it rapidly from one end of the vat to the other, repeating the operation several times.

Before beginning operations the pens, chutes, slide board, vat, etc., should be examined for projecting nails, broken boards, or any object that may puncture or wound the hogs, as the dip may injure those having fresh wounds. Before bringing the hogs to the vat they should be watered, so they will not be thirsty at the time of dipping. They should be handled as carefully as possible and pigs should be "cut out" and dipped separately from the full-grown hogs. To prevent the hogs from piling up and drowning in the dip a gate or other means of checking them and allowing them to pass only as there is room in the vat should be provided in the chute at the intake to the vat.

Men with dipping forks (fig. 8) should be stationed along the vat to render assistance and to keep each animal's body submerged while it is swimming through the vat. The head of each animal should be completely submerged at least once before it leaves the vat. When the heads are ducked the air inclosed in the ears may prevent the dip from wetting their inner surfaces or coming into contact with lice or mange in the lower folds. Care should be taken, therefore, to see that the dip enters the ears of each animal as it passes through the vat. This may be accomplished by slowly pushing the head low enough in the dip so that the liquid flows into the ear from the underside while the air escapes at the top. Splashing the dip with a broom over and into the ears of the animals as they swim through the vat is also a satisfactory method. Dipping forks for handling the animals in the vat, keeping the body submerged, and ducking the head may be purchased ready-made or may be made to order by a blacksmith. (Fig. 8.)

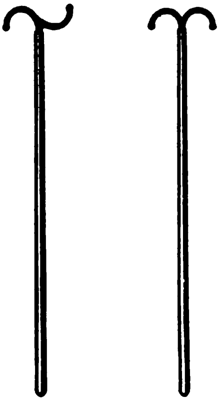


FIG. 8.—Two styles of dipping forks.

After the hogs leave the vat they should be held in draining pens or chutes until all surplus dip has drained off them. They should not be driven long distances or compelled to move rapidly within 24 hours or even longer after dipping, as injury may result from too much exercise or overheating shortly after dipping, especially if oil is used.

Hogs should not be dipped in stale dip that has been used and then allowed to stand for a long time. The dip in the vat should be changed as soon as it becomes filthy, regardless of the number of animals that may have been dipped in it. In cleaning the vat the entire contents, including the sediment and foreign matter, should be removed.

DIPS FOR HOGS.

In selecting a dip for external parasites of the hog the effectiveness of the dip, the effect on the animals, the cost of materials and labor, and the number of applications necessary to effect eradication are important factors to be considered. The less the number of applications necessary to produce the desired results the greater the saving will be in time, money, and labor. While there are several dips on the list recommended for lice and mange, crude petroleum is the only one that will eradicate both lice and mange with one dipping. When crude petroleum is used for dipping no heating equipment is necessary and any kind of reasonably good water may be used. The oil does not apparently injure hogs if the freshly oiled animals receive proper care and attention. Crude petroleum is the most effective and economical known dip for mange and lice, and when it can be obtained its use is recommended in preference to the other dips described.

CRUDE-PETROLEUM DIPS.

Unprocessed crude petroleum is the natural crude oil which has not been subjected to any manufacturing process, and it is probably the most effective crude-oil dip. However, processed crude petroleum, known to the trade as fuel oil, which is the residue from the manufacture of gasoline and other light hydrocarbons, is commonly used as a hog dip and it is effective in eradicating lice and mange. Processed crude oils vary greatly in the number and relative percentages of their constituents and consequently in their consistence. As a rule, the thinner the processed crude oil is the better it is as a dip for hogs. The thick, heavy residue left after the extraction of the lubricating oils is not suitable for use as a dip.

Small quantities of distillate are sometimes added to fuel oil and the product sold at a high price as a special oil having a high degree of efficacy in eradicating mange and lice. The effectiveness of fuel oil for mange may possibly be increased slightly by adding kerosene in the proportion of about 1 quart to each 5 gallons of crude oil, but it is not necessary and it is needless to pay the high prices for the so-called specially prepared oils. There are also on the market several proprietary brands of crude-petroleum dip consisting of processed crude oil to which other ingredients have been added. They usually are effective but cost more than the unmedicated crude oil.

In dipping hogs in crude-petroleum dip, fill the vat with water to within about 6 or 8 inches of the dip line, after which add the oil. The oil floats on the water, forming a layer from 6 to 8 inches deep, depending on the quantity added, and as the hogs swim through the vat their bodies become coated with the oil. The oil dips are used cold and one dipping usually is sufficient to eradicate lice or mange. When crude-oil dip is used it is not necessary to retard the progress of the animals through the vat, as their bodies become coated when they swim directly through.

LIME-SULPHUR DIP.

Lime-sulphur dip is effective in eradicating hog mange when four or more dippings are given with an interval of six or seven days between dippings. It is not effective against hog lice. In dipping hogs for mange the lime-sulphur dip should be used warm. The temperature of the dip while the animals are in it should be maintained at from 95° to 100° F. and visibly affected animals should be held in the dip 3 minutes.

Lime-sulphur dip is made in the proportion of 12 pounds of unslaked lime (or 16 pounds of commercial hydrated lime) and 24 pounds of flowers of sulphur to 100 gallons of water. The lime and sulphur should be weighed and the water measured; do not trust to guesswork. Slake the lime in a shallow, water-tight box or tank and add water enough to form a thin paste. Sift the sulphur into the paste and mix well with a broad hoe until a mixture of about the consistence of mortar is formed, adding water as required. Put the mixture into 30 gallons of boiling water, adding it slowly so as not to interrupt the boiling, and boil until the sulphur disappears from the surface. The boiling should be continued from 1½ to 2 hours without cessation and the mixture stirred to prevent settling and caking on the bottom. When the sulphur has disappeared from the surface and the mixture is of a chocolate or dark-amber color the boiling should be discontinued.

The contents of the boiling tank should be drawn off or dipped out and placed in the settling tank and allowed to stand until all solids have settled to the bottom and the liquid is clear. The use of some sort of settling tank provided with a bunghole is an absolute necessity, unless the boiler is so arranged that it may be used for both boiling and settling. An ordinary water-tight barrel will serve very well for a settling tank at a small vat. A settling tank of any kind should have an outlet at least 4 inches from the bottom in order that the clear liquid may be drawn off without its becoming mixed with any of the sediment. Drawing off the liquid as indicated above has an advantage over dipping it out, for the reason that in the latter case the liquid is stirred more or less and mixed with the sediment. The prime object is to get the clear liquid without any sediment; the latter under no circumstances should be allowed in the dipping vat, as it may injure the animals.

When the sediment has fully settled draw off the liquid into the dipping vat and add warm water enough to make a total of 100 gallons of dip. When mixed and cooked as specified above, the concentrate is 3⅓ times the strength required for the dip in the vat, so that to every 30 gallons of such concentrate 70 gallons of warm water should be added to make a dip of the required strength.

In preparing lime-sulphur dip in large quantities several hundred gallons of concentrate are often made at one time in a single large cooking tank. The quantity made at one boiling is limited only by the facilities at hand. If the boiling tank is of sufficient capacity, a large enough quantity of dip should be cooked at one time to dip the herd. The quantity of mixture in the cooking tank may be varied at will, but the proportions of the various ingredients should not be altered.

Proprietary brands of lime-sulphur dip may be purchased, and many of them are equal to or even better than the homemade product.

Ready-prepared dips should be diluted and used in accordance with instructions on the container.

COAL-TAR-CREOSOTE DIPS.

The coal-tar-creosote dips when properly used in soft water are fairly effective in eradicating hog lice if two or more dippings are given with an interval of 15 or 16 days between dippings. This is necessary because the first dipping does not destroy the eggs. These dips have not proved to be dependable remedies for mange. They may be used cold or warm, but the temperature of the dip while the hogs are in it should not exceed 95° F.

These dips are sold under many different trade names, and the principal ingredient is so-called creosote oil which is made soluble in or miscible with water by means of soap. In the undiluted coal-tar-creosote dips, especially in cold weather, a separation of naphthalene and other constituents of the dip may occur. Care should be taken, therefore, to see that the dip is homogeneous in character before using any portion of it. These dips should be diluted for use in accordance with the directions given on the containers.

ARSENICAL DIP.

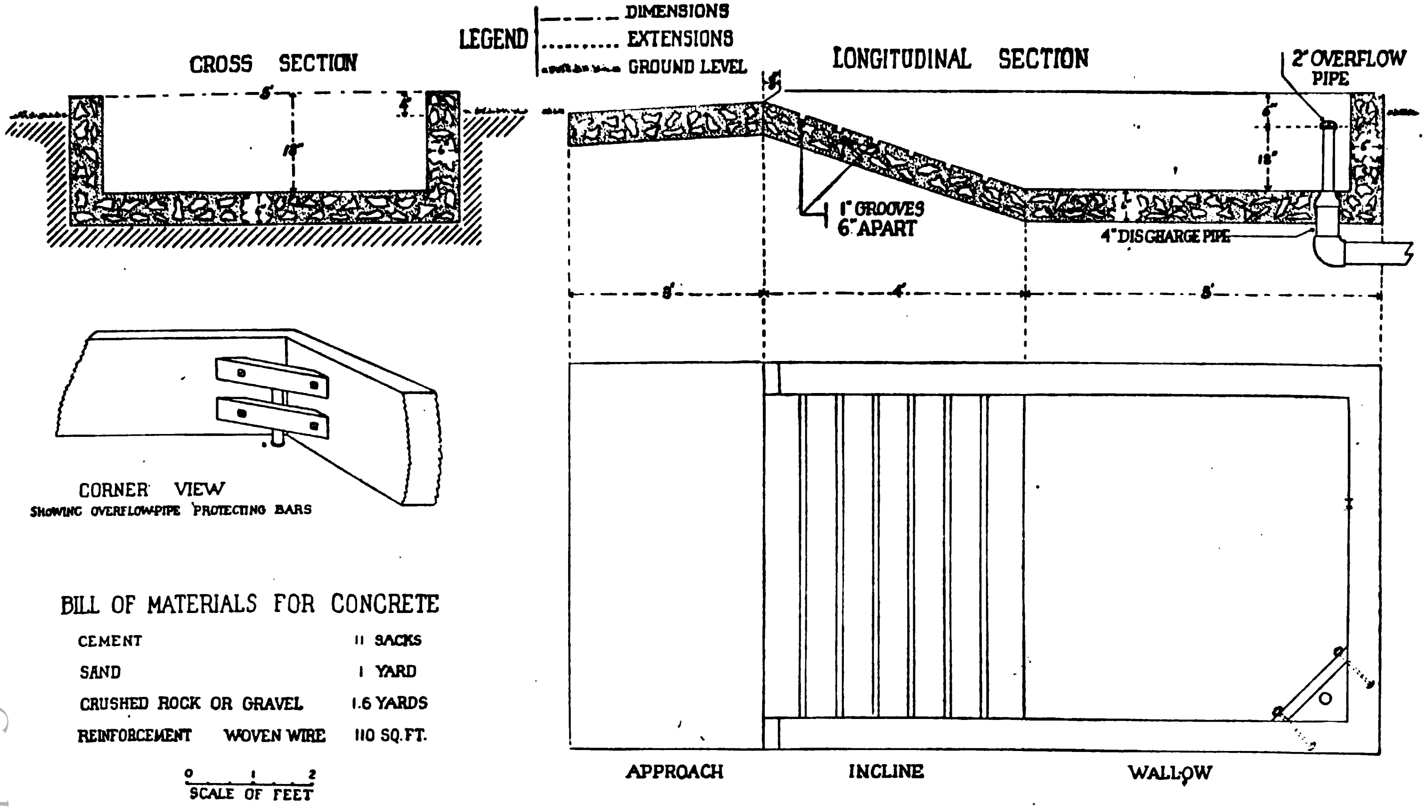
The arsenical dip as used for eradicating cattle ticks in the Southern States is an effective remedy for hog mange when 4 dippings are given with intervals of 6 or 7 days between dippings. As crude-petroleum dip is much more economical and effective, the use of arsenical dip for hogs is not recommended except when a farmer in the southern tick area may have a few infected hogs that he can dip in a cattle vat.

CONSTRUCTION OF HOG WALLOWS.

Hog wallows should be built on ground having good drainage and the surface of the ground should be graded so that there will be no depressions in which water may form pools. When shallow pools or mudholes are accessible the hogs seem to prefer them to any other kind of wallow. It is necessary, therefore, to locate the wallow and arrange the pens so that during treatment the hogs will not have access to any wallows except the one designed for the purpose.

The style of wallow commonly used is shown in figure 7. It may be constructed of either concrete or lumber, the former being preferable because it is more durable and in the long run more economical.

The length and breadth of the wallow may vary, depending upon the individual taste of the owner and the number of hogs kept on the farm. While it is an advantage to have the wallow large enough to accommodate the entire herd at one time, it is not necessary, because all the hogs usually do not visit the wallow at the same time. A wallow of the style and size shown in the plans (fig. 9) will easily accommodate a herd of 20 hogs of various ages.



BILL OF MATERIALS FOR CONCRETE

CEMENT	11 SACKS
SAND	1 YARD
CRUSHED ROCK OR GRAVEL	1.6 YARDS
REINFORCEMENT WOVEN WIRE	110 SQ. FT.

FIG. 9.—Plan of hog wallow—concrete construction.

The top of the side and end walls should extend at least 4 inches above the surface of the ground to prevent surface water from running into the wallow. The entrance and exit incline should have a gradual, easy slope, so that the hogs may safely enter and leave the wallow. To prevent slipping, the concrete floor of the incline should be roughened with a broom soon after it is laid and grooves made in it with a bar, or bricks may be set on edge in the concrete to form cleats or toe holds.

In the Northern States, where the winters are cold, the side and end walls usually are extended into the ground below the frost line to prevent the heaving and cracking of the concrete. In such cases a tar-filled joint is made where the floor joins the walls. The walls and floors should be reinforced with heavy woven fence wire. Place the woven wire in the forms so that it will be embedded in the center of the walls. In building the floor and exit incline, lay the woven wire on top of a 3-inch layer of concrete and cover with a layer of equal thickness.

The system commonly used for draining hog wallows is shown in the plans (fig. 9). The overflow pipe which connects with a discharge pipe acts as a plug when it is screwed into its threaded connection at the floor level. To drain the wallow unscrew the overflow pipe at the floor level. The overflow pipe should be protected so that hogs can not rub against it. This may be done by bolting two pieces of scantling across the corner, as shown in the plans. The bolts and pipe connections should be placed in position before the concrete is laid. The approach to the entrance end of the wallow should be paved with concrete or stone to prevent the forming of mudholes and to protect the ground supporting the floor of the incline.

The general instructions concerning excavations, forms, etc., for dipping vats are applicable to hog wallows and the concrete should be prepared and laid in the same manner.

CONSTRUCTION OF DIPPING PLANTS.

Small herds of hogs such as are kept on the average farm may be dipped in a portable galvanized-iron hog vat, which can be purchased ready-made and answers the purpose very well. (See fig. 10.) In setting the vat an excavation should be made the dimensions of which slightly exceed the outside dimensions of the vat, except the depth, which should be less, so that when the vat is set in the trench the top may extend about 6 inches above the surface of the ground. A crowding chute

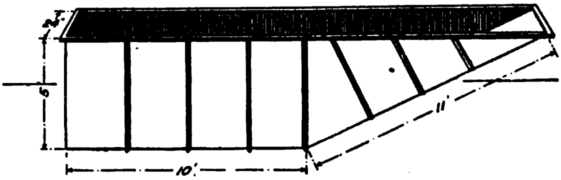


FIG. 10.—Portable galvanized-iron dipping vat.

and a running chute ending in a slide board at the intake end of the vat should be provided and a draining pen or chute should join the vat at the exit or sloping end.

On farms where large numbers of hogs are raised or fed, a permanent dipping plant is more satisfactory and in the long run more economical. Two styles of dipping plants are shown in the plans (figs. 11 and 12) and the chutes, settling well, etc., shown in one set of plans may be substituted if desired for those shown in the other.

SELECTING A LOCATION.

In selecting a location for a dipping plant the fact that animals work better upgrade should be considered, and the corrals and running chute should slope up to the entrance end of the vat. The vat should be on level ground, preferably extending north and south, with the entrance at the south and the exit at the north, as it has been observed that animals work better when not facing the sun. A considerable quantity of water is used in dipping, so the dipping plant should be close to an adequate supply. The vat, however, should not be built on low, marshy land or where flood waters overflow.

PENS AND CHUTES.

The receiving corrals or pens into which the hogs are driven preparatory to dipping should have an opening directly into the forcing or crowding chute. If the draining pens are not large enough to hold the entire herd, holding pens should be provided for the freshly dipped hogs.

The running chute should be at least 20 feet long and preferably curved to prevent the approaching animals from seeing the vat. The width may vary from 18 to 22 inches, depending on the size of the animals, and the sides should be tight-boarded. The height of the chute should be about 40 inches, or high enough to keep the animals from jumping over the sides, but sufficiently low so that the men stationed along the sides to keep the animals moving may work over the top. Hogs will work better in the chute if it slants upward to the slide board.

When hogs emerge from the vat they carry out some of the dip, which runs off their bodies very rapidly. This dip should be saved and returned to the vat, not only because it may be used over and over again but because if it is allowed to drip off in the holding corrals it will collect into pools, from which the animals may drink with possibly injurious results, and even if no hogs are injured in that way the mudholes which form are highly objectionable. Accordingly draining pens with water-tight floors sloping toward the vat or settling wells should be provided to catch and return the dip to the vat. The size shown in the plans may be increased or decreased to correspond to the length of the vat. The floors of the pens may be made of lumber or cement and should have settling wells or water traps to prevent rain from running into the vat and diluting the dip. A design for a settling well is shown in connection with the cement vat and one for a water trap with the wooden vat. The settling well may be used with the wooden vat, in which case the water trap would be unnecessary, as the settling well serves the same purpose.

In constructing the draining pens of cement it is advisable to build the outer walls in the same manner as the foundations for a house, except that they are to be 6 inches thick. The space inside the walls is to be filled with gravel or other suitable materials to the required height and the sloping floors laid on the tamped gravel. To prevent slipping, the cement floors should be roughened with a stiff broom while the concrete is soft, or a coat of pebble dash may be applied. If wooden floors are used they should be double, with a layer of tar paper between the two floors. Rough lumber may be used for the lower floor but the top one should be of matched boards 1 inch thick. Cleats should be nailed on the floor to prevent the hogs from slipping

THE DIPPING VAT.

The dipping vat may be constructed of either concrete or lumber, the former being preferable, because when properly made the vat is more durable and in many other ways more satisfactory than when made with lumber. The sides may be perpendicular if desired, but sloping sides are generally considered to be more desirable than perpendicular ones.

The length of the vat may vary from 20 to 40 feet, depending on the number of hogs to be dipped. The top may extend from 9 to 18 inches above the surface of the ground, or may be flush with it, but the former kind affords better conditions for handling the hogs than one flush with the ground. In either style the ground should be graded up to provide a well-drained path along each side of the vat.

The bottom width of the vat with sloping sides may vary from 6 to 12 inches or even more if desired. The slide board should be made of or covered with a smooth-surfaced material, such as planed lumber, sheet metal, or well-troweled concrete. In order that the exit incline or crawling board may not be too steep for hogs to climb up easily the lower end usually is raised about 12 inches above the floor of the vat. (See figs. 11 and 12.) A false floor made of lumber and having cross cleats to prevent slipping may be bolted to the concrete floor of the exit incline, or bricks set on edge in the concrete will answer the same purpose.

If permanent pipes are used for conducting water and dip to the vat they should be laid so as not to act as obstacles to the men working along the vat, but they should enter the vat above the dip line, so that any leakage may be detected. There should be no obstruction in the paths along both sides of the vat; neither should there be over the top of the vat any crosspieces that may interfere with the proper handling of the hogs while they are in the dip.

In building wooden vats, if softwood is used for the frame timbers they should be 6 by 6 inches, but if hardwood is used 4 by 4 inch timbers are sufficiently large for the purpose. Cedar posts make good framing timbers, as they do not rot rapidly. Matched planks, 2 inches thick, should be used in building the vat, and they should be beveled so that all joints and seams may be properly calked with oakum and rosin, or similar material.

A water trap with hinged cover is shown in the exit incline of the wooden vat. While dipping is in progress both the cover and the valve to the drainpipe should be closed, but when dipping is finished for the day both should be opened, so that, in case of rain, the water from the draining pens may not run into the vat and dilute the dip.

A CONCRETE VAT.

The trench for a concrete vat should be excavated so that the inside dimensions correspond to the outside dimensions of the completed vat. If the sides of the trench are reasonably firm they may be used for the outer walls of the form, but in all cases in which the vat is extended above the surface of the ground it is necessary to build forms extending from the ground surface to the top of the vat. If the soil is sandy, or the walls cave in, it will be necessary to use outer forms, in which case the trench should be wide enough for them.

The forms usually are made of 1-inch boards and 2 by 4 inch braces, and as a supply of lumber usually is necessary for the corrals and chutes some of it may be used first for the forms and afterwards for constructing corrals and chutes.

All bolts and the drain and other pipes should be placed in position in the forms before the concrete is laid. The concrete should be reinforced with heavy woven wire, and the reinforcements should be placed properly in the forms, so that they may be embedded in the middle of the walls.

The concrete for dipping vats should be made of 1 part of Portland cement by measure, 2½ parts of sand, and 4 parts of screened gravel or crushed stone. The sand should be coarse, clean, and free from foreign matter. The crushed stone or gravel may vary in size from one-quarter to 1 inch in diameter. The mixing should be done on a smooth, tight platform and the sand and rock measured separately in a bottomless box 2 feet long, 2 feet wide, and 1 foot deep, having a capacity of 4 cubic feet. For the 2½ cubic feet mark the inside of the box 7½ inches up from the bottom. Each sack of Portland cement is considered to be equal to 1 cubic foot. Mix the sand and cement thoroughly, add the crushed stone (previously drenched with water), and mix the whole mass by turning it several times with

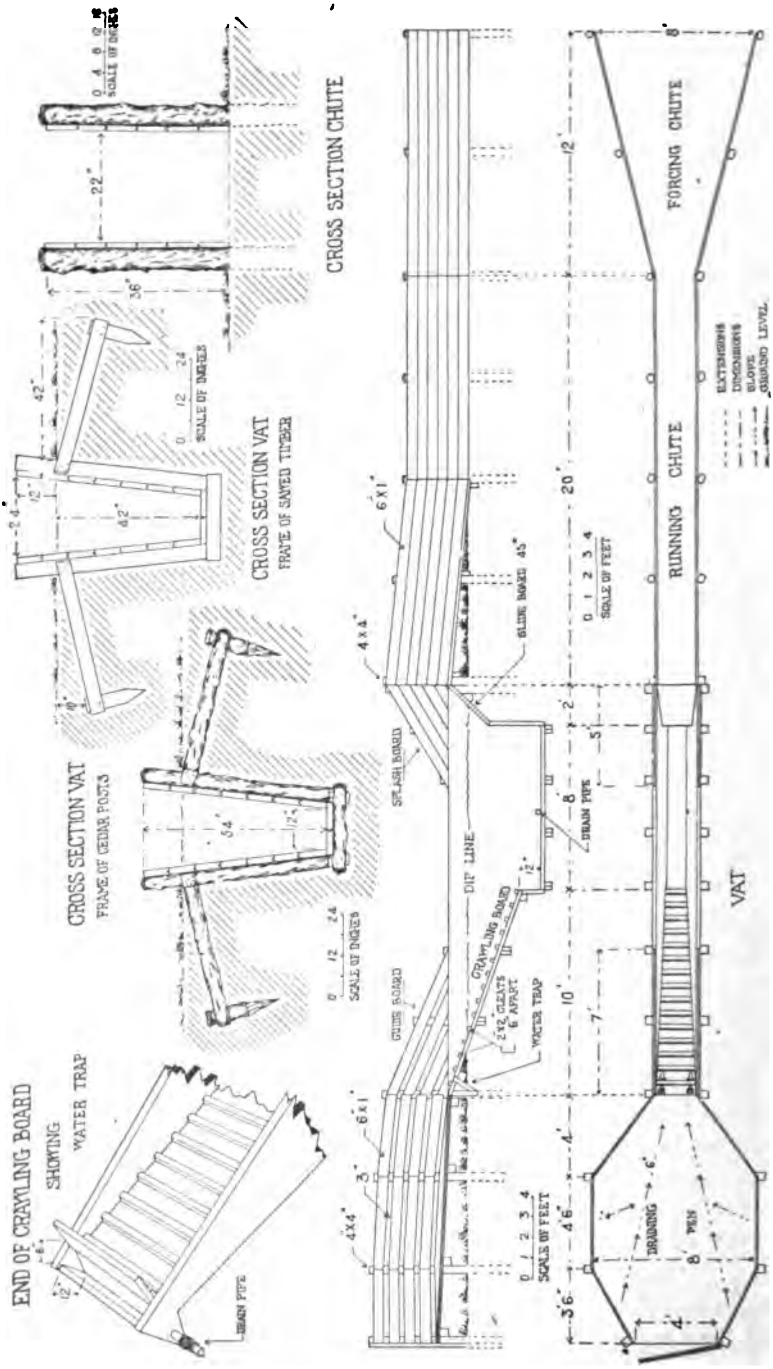
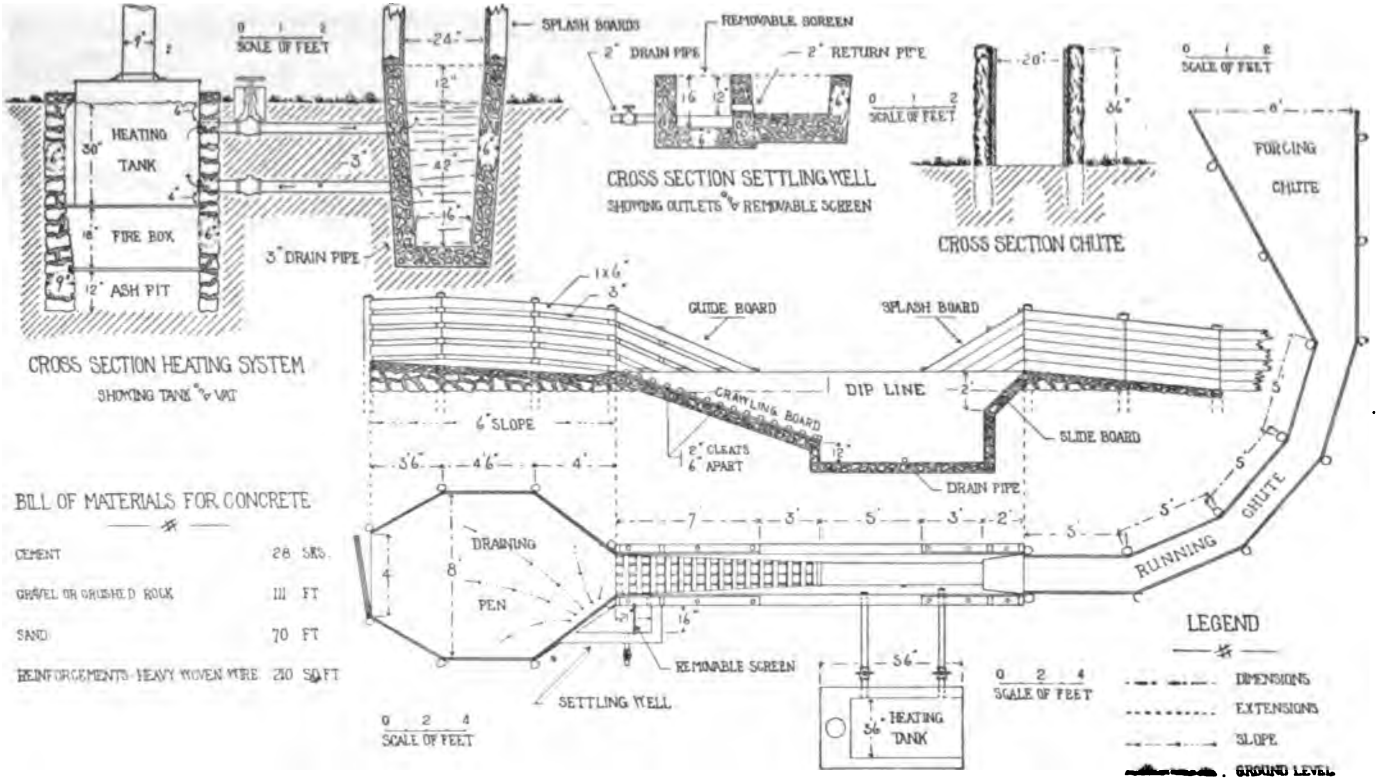


FIG. 11.—Plan of hog-dipping vat—wooden vat.



BILL OF MATERIALS FOR CONCRETE

CEMENT	28 SKS.
GRAVEL OR CRUSHED ROCK	111 FT
SAND	70 FT
REINFORCEMENTS HEAVY WOVEN WIRE	210 SQ FT

FIG. 12.—Plan of hog-dipping vat—concrete vat.

shovels. Then add water in a depression made in the center of the pile and mix well by turning several times with shovels, adding water enough during the mixing to make a "quaky" or thin, jellylike mixture.

The placing of the concrete in the forms should be commenced as soon as the mixing is finished. The floor and exit end should be laid first and the concrete well tamped. In filling the forms the concrete should be well settled into place by spading rather than by tamping, and special attention should be given to spading next to the inside forms to force the coarse particles back and allow the sand-cement mortar to form a dense, water-tight surface. An old hoe straightened out makes a good spading tool, as the handle is long enough to reach the bottom of the forms. If it is necessary to stop work for the day before the forms are filled the surface of the concrete in the forms should be roughened with a stick. Just before placing additional concrete wash the roughened surface and paint it with cement and water mixed to the consistence of thick cream. Leave the forms in place two or three days, if possible, and wet the concrete daily. After the forms are removed, dampen the surface of the concrete and apply a finishing coat composed of 1 part of cement and 2 of sand, or mix cement and water to the consistence of cream and apply it, brushing well to form a smooth surface.

HEATING FACILITIES.

Heating equipment in connection with the dipping plant is not necessary when crude-petroleum dip is used, but when homemade lime-sulphur dip is used it is necessary to provide facilities for cooking the dip and also for heating it in the vat. The cooking may be done in open kettles or tanks, having a fire box under them, or live steam may be piped into them for boiling the dip.

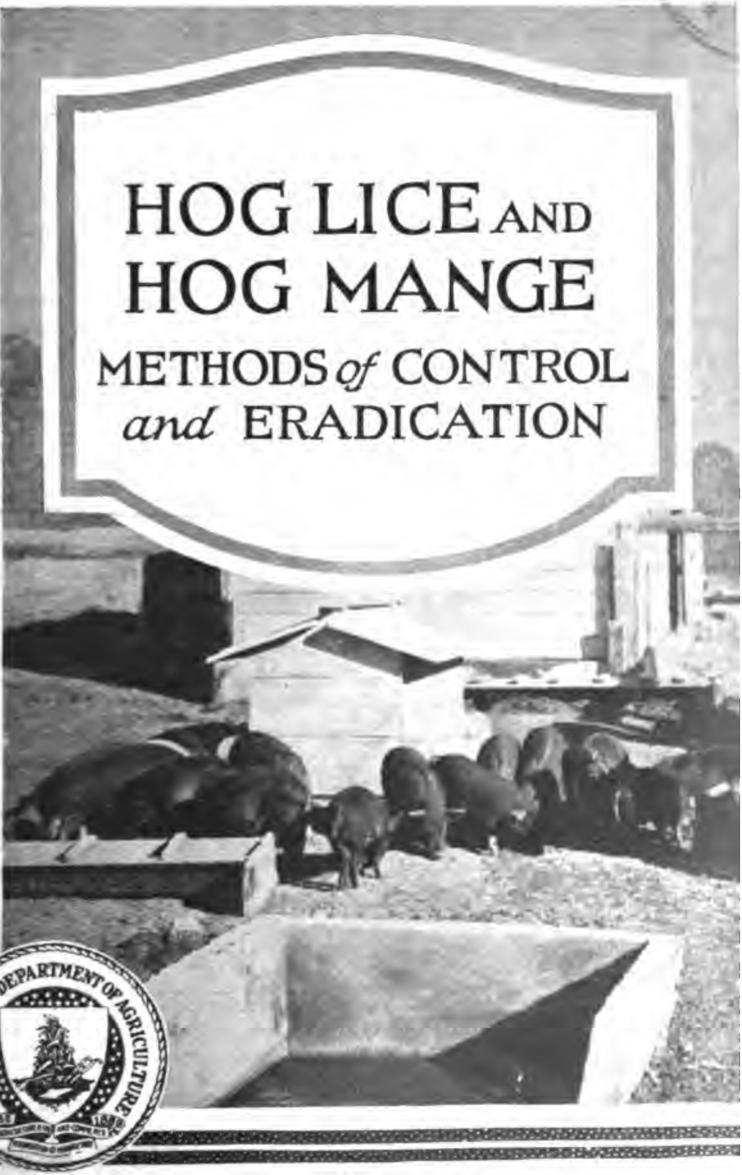
The commonly used system of heating the dip in the vat is to pipe live steam directly into the liquid from a steam boiler. The steam pipes usually are extended along the floor of the vat at least two-thirds the length, and are provided with openings for the escape of steam into the dip. When the open-tank heating system, shown in the plans for a concrete vat, is used, settling wells are not necessary, as the heating tank answers the purpose of a settling well.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

A
No.

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1085



HOG LICE AND HOG MANGE

METHODS *of* CONTROL *and* ERADICATION

LICE AND MANGE mites are the two principal kinds of external parasites affecting hogs. They are injurious to all classes of hogs, but the greatest losses occur in pigs and poorly nourished hogs kept in insanitary quarters.

The losses are caused by irritation, unthrifty condition, functional disturbances, arrested growth, low vitality, and increased death rate.

Only one species of lice commonly affects hogs, and this parasite obtains its food by puncturing the skin of the host and sucking blood. It can be eradicated by hand applications, spraying, medicated hog wallows, and dipping. Dipping is the best method of applying treatment. Crude-petroleum and coal-tar-creosote dips are effective remedies. The proper interval between dippings is from 14 to 16 days.

Two species of mange mites commonly affect hogs. The nature and habits of these mites, the symptoms caused by each species, and the methods of control and eradication are discussed in this bulletin. Crude-petroleum and lime-sulphur dips are effective remedies for common or sarcoptic mange of hogs, and the proper interval between dippings is from five to seven days.

Plans of hog wallows and dipping plants, together with directions for building them and for dipping hogs, are given.

Washington, D. C.

Issued May, 1920;
Revised February, 1931

HOG LICE AND HOG MANGE

METHODS OF CONTROL AND ERADICATION

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HOG LICE

DISTRIBUTION AND ECONOMIC IMPORTANCE

Hog lice occur more or less frequently on both domesticated and wild hogs in practically all parts of the world. The parasites are prevalent in all parts of the United States where hogs are raised, and livestock growers generally recognize them as a pest that causes considerable loss to the swine industry.

In obtaining their food the lice puncture the skin of the host animal and suck blood and lymph. A new puncture in the skin is made each time a louse feeds. A single puncture causes considerable irritation and itching, and as each louse feeds at frequent intervals, the irritation and itching is almost constant in cases of gross infestation. In an attempt to relieve the intense itching the infested animals scratch themselves with their feet and rub violently against any convenient object. The frequent rubbing destroys the hair in patches and often causes wounds in the skin. The lice congregate around the abrasions and thus cause further irritation.

Lice may attack hogs of any age or condition, and if allowed to spread the infested animals suffer and the owner loses in the increased quantity of feed consumed per pound of gain, arrested growth of young pigs, and shrinkage in weight of fattening hogs. When young pigs become infested at an early age from the brood sow and the lice are allowed to remain on the animals until the hogs are ready for butchering, the loss caused by the parasites is a considerable item in the cost of producing pork. Estimates based on observations and limited experimental data fix the direct money loss in such cases at from 2 to 6 per cent of the market value of the hog. The indirect losses caused by lice are seldom taken into consideration, because on casual observation they are not so apparent. Hogs infested by large numbers of lice suffer a lowering of vitality and a generally unthrifty condition which renders them more susceptible to attack by other parasites and by contagious diseases. The damage and losses caused by hog lice are of sufficient importance to warrant the application of treatment for their eradication.

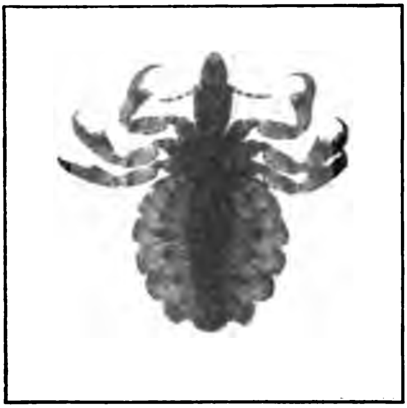


FIG. 1.—Male hog louse

NATURE AND HABITS

The hog louse, known technically as *Hæmatopinus suis*, is a bloodsucking parasite and one of the largest of the lice affecting domestic animals. The full-grown female often attains a length of one-fourth of an inch. The male louse is slightly smaller and can be distinguished by a black streak on the underside of the abdomen along the middle of the last three segments. The feet are adapted for clasping the hairs, and the lice travel sidewise through the hair or bristles of the hog.

The entire life cycle is passed on the host. The females deposit and glue their eggs or "nits" on the hairs close to the skin. This may occur on any part of the body, but the favorite locations are the lower half of the sides, around the neck, shoulders, and flanks. The female lays from 3 to 6 eggs a day and the average length of the egg-laying period is about 25 days. The average number of eggs laid by the female louse during her lifetime is about 90. The eggs hatch on the host in from 12 to 20 days, the majority hatching in from 12 to 14 days. The young lice become active soon after hatching and seek the parts covered by tender skin for feeding. The favorite location for young lice, especially during cold weather, is the inside of the ear, where they often congregate in large clusters and where the skin is tender and they are protected from the cold and also from the efforts of the host to dislodge them. When a suitable place is found the young louse punctures the skin with its sharp mouth parts and sucks blood until satisfied.

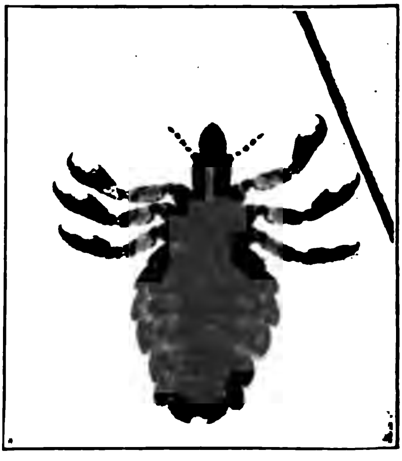


FIG. 2.—Female hog louse and egg attached to hair. (Photomicrograph by Dr. W. T. Huffman)

Hog lice do not remain attached to the skin like ticks, but detach after each feeding and wander about through the hair or remain quiet, either singly or in groups. They feed at frequent intervals and develop rapidly. The young lice reach maturity and mating occurs when they are about 10 days old. The females begin laying eggs when they are about 12 days old and the average length of life is about 35 days.

Except in accidental cases, hog lice are found only on hogs, and they do not voluntarily leave their natural host. When separated from the animal they live only two or three days. The lice pass readily from one hog to another when the animals come in close contact. Practically all cases of infestation occur from contact with lousy animals and not from infected premises. Under reasonably good sanitary conditions pens, corrals, and premises which have contained lousy hogs are not a source of danger to hogs free from lice. As a precautionary measure, however, and because it is good sanitary practice, all small inclosures which have contained lousy hogs should be cleaned and disinfected before being used for a new lot of hogs. The litter and manure should be removed and the floors cleaned, after which the woodwork and floors should be sprayed with a good disinfectant. The coal-tar-creosote dips, diluted in accordance with instructions on the container, are suitable for this purpose.

HOG MANGE

VARIETIES AND GENERAL CHARACTERISTICS

Scabies in hogs, commonly known as mange, is a term applied to two contagious skin diseases caused by insectlike parasites known as "mites," which live in the skin. The two species of these parasites which affect hogs are classified in two different genera—*Sarcoptes* and *Demodex*.

Mange mites spend their entire life on the host animal. In obtaining their food from the tissues and blood of the affected animal the parasites cause wounds or lesions in the skin. As each kind of mite possesses distinctive habits in its manner of feeding and other activities, the nature and location of the lesions caused by them are more or less characteristic. The sarcoptic mites, which cause common hog mange, burrow into the skin, each female making a separate gallery in which she lays her eggs. The skin over and around the burrow or gallery becomes irritated and inflamed and a small cone-shaped swelling is formed. The demodectic mites, which cause demodectic or follicular mange, are very small and in appearance somewhat like microscopic worms. They live in colonies or groups in the hair follicles and sebaceous glands and cause small, spherical, hard swellings.

SARCOPTIC OR COMMON MANGE

Sarcoptic or common mange occurs in hogs in the United States much more frequently than the follicular variety. Although the disease has not become highly prevalent in any one section, it seems to be increasing throughout the Corn-Belt States. Other sections, even those parts of the West where a comparatively small number of hogs are raised, have more or less hog mange. Traffic in breeding stock evidently has been an important factor in spreading the disease. Like scab in other species of animals, hog mange spreads rapidly under favorable conditions unless active measures are taken for its control. Although pigs, young growing stock, and old, poorly nourished animals of low vitality suffer most from the ravages of mange, the disease often attacks vigorous, mature hogs and causes great losses. The losses are caused by irritation, arrested growth, unthrifty condition, decreased vitality, functional disturbances, and increased death rate. The disease, however, can be eradicated, and if proper methods are adopted before it becomes advanced the losses can be reduced to a minimum.

THE SARCOPTIC MANGE MITE

The mites which cause sarcoptic mange are small, whitish-colored parasites known technically as *Sarcoptes scabiei suis*. The mature female measures about one-fiftieth and the male about one-sixtieth of an inch in length. Although they are visible to the naked eye, particularly if placed on a dark background, it is advisable to use a low-power magnifying glass in examining scrapings or material suspected of containing the mites. The general form of the body is round and the bluntly rounded head is as broad as it is long. When mature these mites have four pairs of short, thick legs, the fourth pair and usually the third pair not extending beyond the margin of the body. A conspicuous feature under a high-power microscope is the presence of a considerable number of short, backward-projecting spines on the upper surface of the body.

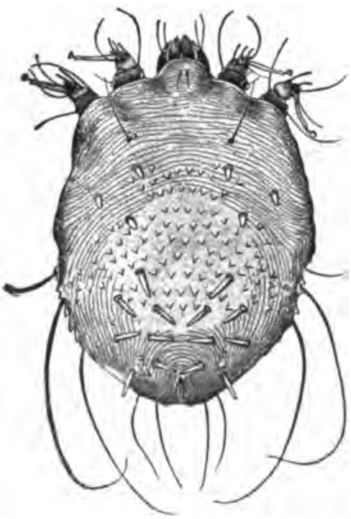


FIG. 3.—Sarcoptic mange mite. Female. Magnified 100 times

The entire life cycle is passed on the body of the host animal. The mites penetrate through the upper layer of the skin and excavate burrows or galleries in which the eggs are laid. Each female may lay from 10 to 25 eggs during the egg-laying period, which probably lasts from 12 to 15 days, after which the female dies in her burrow. The eggs hatch in from 3 to 10 days and the young mites after passing through several molts reach maturity and begin laying eggs in 10 or 12 days. As the surface of the skin constantly is wearing away and being renewed from below, the young mites are close to the surface when they hatch out. They escape from their shallow burrows and form new ones in which they in turn deposit their eggs.

As the average period of incubation on the animal is about 4 days and the average period after hatching until egg laying begins is about 11 days, a new generation of mature mites may be produced about every 15 days.

SYMPTOMS OF COMMON MANGE

Sarcoptic mange of hogs may start on any part of the body but in the early stages of the disease the lesions usually are found on the head, around the eyes, nose, or ears. From these parts it spreads over the neck and shoulders and along the back and sides, finally involving the entire body.

The parasites penetrate the upper layer of skin, each one forming a separate burrow or gallery in which it lives. The presence of the mites on the "quick" or sensitive tissues causes great irritation and the skin over and around each burrow becomes inflamed and swollen. These swollen areas are somewhat larger than pinheads and often have a yellowish-colored granule of dried serum adhering to them. As the mites multiply, the diseased area increases and the granular or raised areas become closed together. The hair over the affected part stands erect and some of it drops out or is rubbed off, though usually a few scattering hairs remain even in advanced cases. The affected areas of skin often take on a dry, scurfy, or leatherlike appearance, especially when the mites are not very active. Such cases are known as the dry form of mange, and in this form the rubbing of the animal often has a sort of polishing effect upon the dead scales of the skin and the dried serum, and the affected areas may have a dry, slightly glistening, silver-gray appearance.

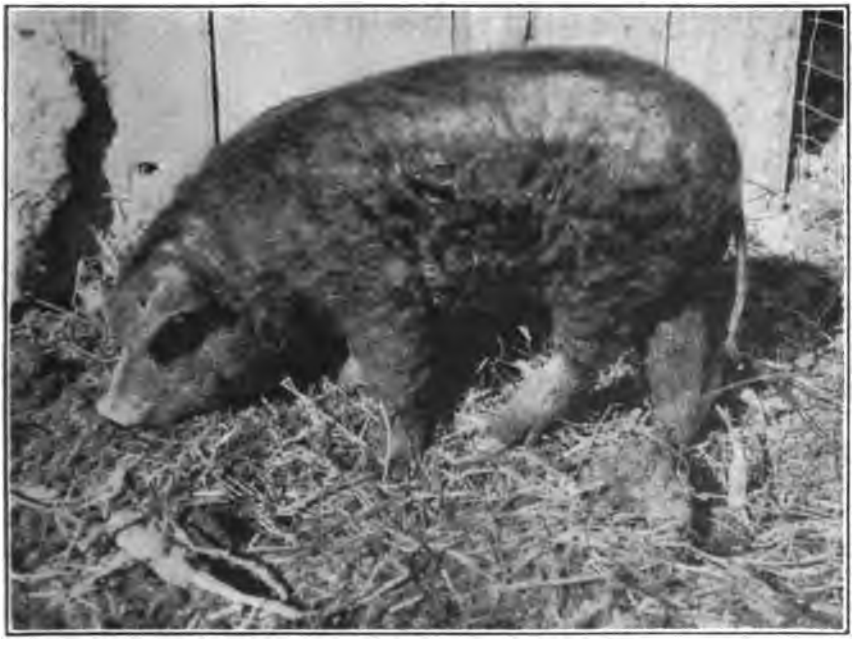


FIG. 4.—A case of hog mange in the early stages of the disease

The intense itching causes the animal to scratch and rub the affected parts until the skin becomes raw. The mechanical injury thus caused results in a running together of the small granular areas and large scabs are formed. The large scabs, which are firmly attached to the underlying skin, often are broken by the movements of the animal and blood and serum ooze out of the cracks. The surface of the lesion may have a dry, pearl-gray appearance or it may be moist and stained a reddish yellow by blood and serum. In chronic cases the odor from the moist form sometimes is very offensive.

As the disease advances the skin becomes more or less bare and is hard, greatly thickened, and thrown into wrinkles or folds. The furrows formed by the wrinkles are thickly inhabited by mites and scrapings taken from the bottom of a fold usually contain the parasites in abundance. In severe cases the animals rapidly lose flesh, become emaciated and greatly weakened, and unless properly treated many of them will die.

The most certain diagnosis consists in finding the mites, which are the sole cause of the disease. On account of their burrowing habits the parasites often are difficult to find, especially in the early stages of the disease. By scraping the affected area with a blunt-edged knife until the blood flows and examining the scrapings in the warm sunshine or near artificial heat under a low-power magnifying glass the mites may be found. In doubtful cases the scrapings may be soaked in a 10 per cent solution of caustic potash and examined under a microscope.

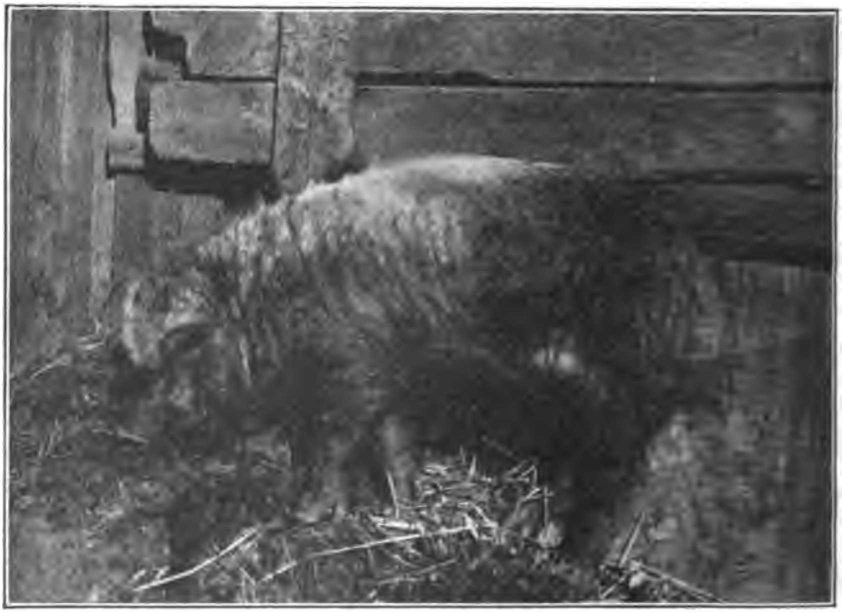


FIG. 5.—A case of advanced hog mange showing wrinkled condition of skin

CONTAGIOUSNESS OF COMMON MANGE

Sarcoptic or common mange of hogs is contagious and is usually spread by direct contact with infected animals. The disease is readily transmissible to man and also from hogs to some other animals. In such cases the mites generally live only a limited time on the new host. The disease may persist in man for 30 days or longer and cause extreme annoyance. It is advisable to bathe and change clothing as soon as possible after handling mangy hogs.

As the sarcoptic mites live in their burrows, they do not spread to other animals so rapidly as those varieties which live solely on the surface of the skin, but on account of the hogs' habit of sleeping in close contact with one another the disease often makes great headway in herds confined in pens or stables. The infection spreads rapidly under various insanitary conditions, such as crowded or unclean quarters, exposure to cold, inclement weather, insufficient feed of poor quality, or any other circumstance tending to lessen the vitality or functional activities of the animals. The spread of the disease is not limited to any one season of the year, although healthy hogs seldom become infected during the summer months, especially if they have access to green succulent feed and are kept in open lots or fields where they are exposed to the sunshine.

Hogs of all classes, ages, and conditions are susceptible to sarcoptic mange, but usually the disease does not spread rapidly in well-fed, vigorous animals kept in sanitary quarters. The weak, unthrifty animals are the first to show lesions of the disease after exposure to the infection and the mites spread from them to other hogs with which they come into contact. Visible lesions of mange may develop in from 14 to 45 days after exposure, or a much longer time may elapse before the exposed hogs show indications of infection. Cases of mange may become generalized in 6 weeks, or a much longer time may elapse before the lesions spread to any great extent.

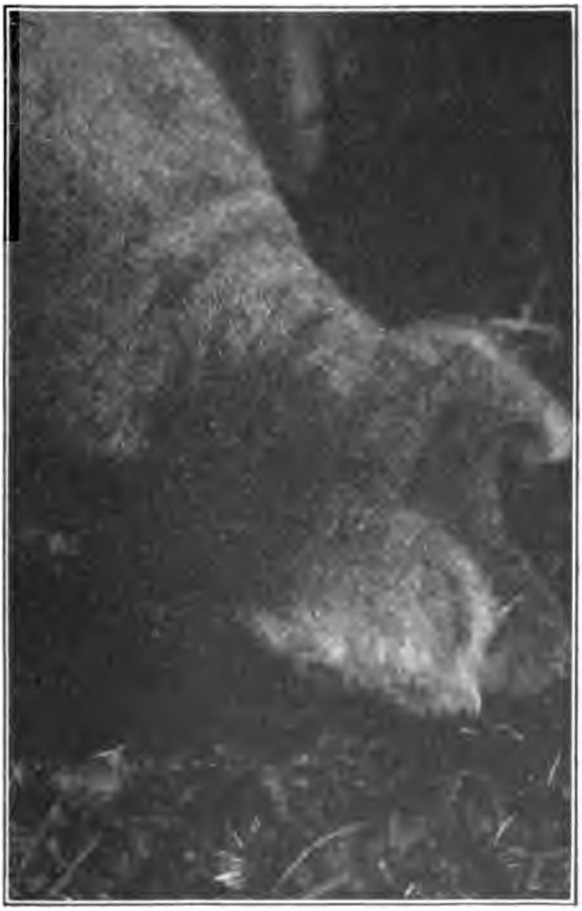


FIG. 6.—Advanced hog mange showing pedicel-like scabs

One or more attacks of the disease do not confer immunity, and after the disease has been cured the animals may become reinfected by contact with infected hogs or possibly by confinement in small inclosures in which mangy hogs have recently been kept. While practically all cases of hog mange seem to originate from contact with infected animals, the possibility of animals becoming infected from infected premises should not be overlooked. Although the mite will not reproduce itself except on the bodies of animals, it is able to live for two or three weeks when removed from hogs, and under favorable conditions may live much longer. Dislodged eggs which drop in moist, protected places may retain their vitality for from two to four weeks during mild weather. In dry places exposed to bright sunshine the mites and eggs are destroyed in a few days.

While the results of a large number of experiments indicate that hogs do not contract mange from infected premises, nevertheless, in actual practice, cases occur which seemingly can be explained on no other ground. It is advisable, therefore, to clean and disinfect all hog houses, pens, sheds, or small inclosures in which mangy hogs have been confined before using them for healthy hogs. Remove all litter and manure, cleaning down to a smooth surface, then spray all walls, woodwork, and floors with a good disinfectant. The coal-tar-creosote dips and disinfectants diluted in accordance with instructions on the containers are suitable for this purpose. The manure or litter from infected pens or buildings should be spread on the ground and plowed under or disposed of in such manner that hogs can not come into contact with it, and all troughs and implements used in the infected inclosures should be immersed or washed in the disinfectant.

DEMODECTIC (FOLLICULAR) MANGE

Demodectic or follicular mange of hogs is caused by minute wormlike mites known technically as *Demodex phylloides* or *Demodex folliculorum suis.* Similar follicle mites occur in dogs, cattle, and other animals, and also in man. The parasites are truly microscopic in size, the full-grown female measuring approximately one one-hundredth of an inch in length. They penetrate into the hair follicles and sebaceous glands of the skin, where the entire life cycle is completed. When present in small numbers they apparently cause the animal no serious inconvenience, but occasionally they increase rapidly and cause well-marked lesions in the skin of the affected animal. The disease is contagious to all classes of hogs.

The lesions usually appear first on the snout or around the eyelids and spread slowly from these parts over the underside of the neck, breast, abdomen, inner sides of the hind legs, and other parts of the body where the skin is thin and tender. The back and upper part of the sides where the skin is thick and tough usually are not affected. In the early stages of the disease the affected skin may be red and scurfy, and small, hard, nodular lumps ranging in size from that of a pinhead to that of a hazelnut appear in the skin. The nodules may be dark red or they may be light red with a whitish or cream-colored center. As the disease advances the nodules break and discharge a creamlike pus or lumps of matter of a cheeselike consistence. Two or more of the nodules may break and run together, forming suppurating cavities.

There is no known specific cure for demodectic mange, although frequent dippings in crude petroleum check the progress of the disease and heal many of the old lesions. Herds in which demodectic mange appears should be dipped in or treated with crude petroleum, and any animals having advanced cases which do not respond to treatment should be killed. The remainder of the herd should be fattened for market and disposed of and the premises cleaned and disinfected before being restocked with healthy hogs. The cleaning and disinfecting of premises is the same as for sarcoptic mange.

TREATMENT FOR LICE AND MANGE

The five commonly used methods of applying treatment for external parasites of hogs are (1) hand applications, (2) spraying, (3) hog oilers, (4) medicated wallows, and (5) dipping. Dipping is the best method and should be used if practicable.

If no dipping vats or wallows are available or if the weather is too cold for dipping, hand applications are beneficial in checking the spread of lice or mange until the weather is suitable and arrangements can be made for dipping. Treatment of hogs in a dipping vat or in medicated wallows during the mild weather of autumn is a good insurance against the risk of loss from mange and lice and the probable additional expense of winter treatment. In applying treatment for either mange or lice the entire herd should be treated whether all the animals show infection or not. Sows heavy with pig, however, should not be dipped within two weeks of their farrowing time or too soon after farrowing. When the pigs are about 3 weeks old the sow and pigs may be dipped without undue risk, but all the pigs of the litter should be dipped or treated in the same manner as the sow, to prevent the sow from failing to recognize and refusing to suckle any that are not dipped.

HAND APPLICATIONS

On account of the difficulty of restraining hogs and covering the entire surface of the body by hand applications, this method of applying treatment should be used only as a temporary makeshift until the animals can be dipped or treated in wallows. The following remedies, when applied by hand, have proved to be effective for lice and mange: (1) Crude petroleum, (2) cottonseed oil and kerosene, equal parts, and (3) kerosene and lard mixed in the proportion of one-half pint kerosene to 1 pound of lard. These remedies may be applied with a brush, mop, or cloth and they should be distributed in a thin, even coating over the entire surface of the head and body, including the inner surfaces of the ears and between the thighs. When treatment is being applied for mange special care should be taken to see that all spots of scab are well coated. Freshly oiled or greased hogs should not be moved rapidly, exposed to bright sunshine, or allowed to become chilled, as injury to the animals may result.

Crude petroleum is the most effective known remedy for lice and mange and on account of its spreading, adhesive, and protective qualities it is the most suitable for use in hand applications. It may be applied with a can having a flattened spout or from an ordinary sprinkling can having large holes in the sprinkler. The practice of throwing feed on the ground and sprinkling oil on the hogs while they are eating is not recommended, because more or less of the oil falls on the feed and is consumed by the animals. A better method is to restrain the hogs during the application of the oil by crowding them in small pens or inclosures. When the oil is applied by sprinkling or pouring, it usually does not reach the inner surface of the ears, which should be given supplementary treatment with a swab that has been dipped in the oil.

SPRAYING

Spraying is not so economical or effective as dipping because of the difficulty of thoroughly wetting hogs with a spray from an ordinary spray nozzle. Much of the dip runs off and is wasted, and unless plenty of it is used and the spraying is continued until all parts are well soaked the treatment will not be effective. Mange and lice can be eradicated by spraying, however, if the work is done properly. An ordinary hand spray pump is suitable for the purpose, or where an orchard-spraying outfit is available it may be used. Any of the dips recommended for scab may be applied in the form of a spray and the interval between sprayings should be the same as those between dippings.

HOG OILERS

Hog oilers or rubbing posts are devices so arranged that when a hog rubs against them a small quantity of oil is deposited on or near the spot of skin being rubbed. They may be divided into two general classes: (1) Homemade rubbing posts and (2) the patented hog oilers. The first usually consists of a post set firmly in the ground and wrapped securely with gunny sack or rope that is kept saturated with oil. The oil is poured over the post covering from time to time or a can of oil is fastened to the top of the post and the rope or gunny sack is kept saturated by fastening the upper end in the vessel of oil. There are various types of patented hog oilers on the market and many hog growers in the Corn-Belt States have one or more of them in their hog lots.

When a hog desires to rub itself it does not go to a rubbing post or hog oiler unless it happens to be close to one, but it rubs against the first convenient object it finds. At best only a limited area of skin is covered with oil when a hog rubs against an oiler; consequently the various oiling devices are not successful in eradicating external parasites. When the oil containers are kept supplied with oil and the machine not allowed to become clogged with mud, the use of hog oilers tends to lessen the spread of lice and mange, but they should not be depended upon to effect eradication or even to prevent the losses caused by gross infestation of mange mites or lice.

MEDICATED HOG WALLOWS

The instinctive habit of the hog to wallow in water when the weather is warm may be taken advantage of in applying treatment for external parasites. By medicating the water in properly constructed wallows (for plan see fig. 8, p. 17) remedies for lice and mange may be applied in a satisfactory manner with a minimum expenditure of money, time, and labor. If the results from the use of medicated wallows are to be satisfactory, however, it is necessary to consider the nature and habits of the animals to be treated, and plan accordingly.

If conditions are such that hogs may exercise choice in the matter, they invariably select shallow water in which to wallow. When a hog wades into water it apparently tries to measure the depth and learn the nature of the bottom by submerging its nose and face, and if the water is too deep the animal may squat on its haunches or assume a recumbent attitude, resting on its chest and abdomen with the legs folded under and the head elevated, but it does not lie down on its side. If the water is sufficiently shallow so that the nostrils can be kept above the surface of the liquid easily the hog lies down on its side and rolls and then gets up and repeats the operation on the other side until the entire surface of the body is wet. As a volume of liquid is displaced when a hog lies down in the wallow the water line is raised accordingly, and the greater the number of hogs lying in the wallow at one time the higher the water line is raised. The proper depth of liquid in the wallow, therefore, depends upon the size and number of hogs using the wallow.

For pigs weighing from 40 to 80 pounds the wallow should be charged with liquid to a depth of about 3 inches. For hogs weighing from 80 to 150 pounds about 4 inches of liquid is sufficient. The depth may be increased to 5 or 6 inches for heavier hogs, but the medicated liquid in the wallow should never be so deep that the hogs are afraid to lie down and wallow in it. When only one wallow is available for a mixed lot of hogs of various sizes, from 3 to 4 inches of liquid will give better results than a greater depth. The water should always be shallow and no medicine added until the hogs have become well accustomed to using the wallow. After the habit of using the wallow is well fixed, which usually requires 3 or 4 days, the depth may be increased if necessary and the medicaments added.

The wallow should not be kept medicated continuously, as the medicament when applied too often is liable to cause irritation and the hogs may refuse to use the wallow after a few days. In from 24 to 48 hours after the liquid in the wallow has been medicated all hogs probably will be well soaked and the wallow should be drained and cleaned and recharged with water only. Medicaments may be added every week or ten days until the desired results are obtained.

Hogs are liable to drink from the wallows unless the water is denatured by some distasteful substance. Because of their denaturing qualities, their tendency to spread over the surface of the body, and their effectiveness as a remedy for external parasites, crude petroleum and the oils derived from crude petroleum are the most suitable dips for use in hog wallows. In using oil in wallows add about 1 pint for each pig and about 1 quart for each hog. Observe whether all the animals use the wallow and whether their bodies are well coated with the oil. If all are not well coated add more oil to the wallow.

The oil floating on the surface of the water limits or prevents evaporation and if the wallow is exposed to the direct rays of the sun during the hot summer months the water becomes heated to such a degree that the hogs will not lie in it. It is advisable, therefore, to construct a shade over the wallow or to add the oil in the evening. Oil added after sundown usually is carried out on the bodies of the hogs before noon of the next day.

A shady, well-ventilated place should be provided for freshly oiled hogs. All wallows should be drained and cleaned as often as necessary to keep them and the surroundings in good sanitary condition.

DIPPING

Dipping consists in immersing animals in a medicated liquid that will kill the parasites. It is the most effective known method of applying treatment. Dipping plants are usually arranged so that the hogs enter one end of the vat filled with dip, swim through, and leave the vat at the opposite end. During dipping, the liquid in the vat should be from 40 to 48 inches deep, which is sufficient to swim the tallest animal. The quantity of dip necessary to complete the work should be ascertained and materials sufficient to make that quantity provided before the work of preparing the dip is begun. The average 100-pound hog will carry out and retain from 1 to 1½ pints of dipping solution and full-grown hogs will retain about 1 quart. The total estimated quantity of dip which the animals carry out and retain plus what is required to charge the vat should equal the total quantity required to complete the work if none is lost by leakage or otherwise.

The capacity of the vat is usually calculated in the following manner: Multiply the average length in inches by the average width in inches, then the product by the depth in inches; this will give approximately the number of cubic inches of space to be filled with dip. Divide this by 231 (the number of cubic inches in a gallon), and the result will be approximately the number of gallons of dip required to charge the vat. To obtain the average length add the length at the bottom to the length at the top (that is, at the line to which the vat is to be filled), and divide the sum by 2. Obtain the average width in the same manner. The depth should be taken at the middle of the vat, and should be from the bottom to dip line only and not to the top of the vat. Likewise, in determining the length and width, measure only the space to be filled with liquid and not above that line. The capacities of any tanks that are used are obtained by a like process. Gauges or rods should be prepared and marked to show the number of gallons at various depths in the vat and tanks.

After the vat is filled to the required depth with any of the dips except oil, the contents should be mixed well by stirring, in order that the dip may be of uniform strength and temperature throughout. A good method of stirring the dip is to take a pail or empty dip container in which a wire bail has been fastened, attach a rope or dipping fork to the bail, allow the vessel to fill and partially sink, then drag it rapidly from one end of the vat to the other, repeating the operation several times.

Before beginning operations the pens, chutes, slide board, vat, etc., should be examined for projecting nails, broken boards, or any object that may puncture or wound the hogs, as the dip may injure those having fresh wounds. Before bringing the hogs to the vat they should be watered, so they will not be thirsty at the time of dipping. They should be handled as carefully as possible and pigs should be "cut out" and dipped separately from the full-grown hogs. To prevent the hogs from piling up and drowning in the dip a gate or other means of checking them and allowing them to pass only as there is room in the vat should be provided in the chute at the intake to the vat.

Men with dipping forks (fig. 7) should be stationed along the vat to render assistance and to keep each animal's body submerged while it is swimming through the vat. The head of each animal should be completely submerged at least once before it leaves the vat. When the heads are ducked the air inclosed in the ears may prevent the dip from wetting their inner surfaces or coming into contact with lice or mange in the lower folds. Care should be taken, therefore, to see that the dip enters the ears of each animal as it passes through the vat. This may be accomplished by slowly pushing the head low enough in the dip so that the liquid flows into the ear from the underside while the air escapes at the top. Splashing the dip with a broom over and into the ears of the animals as they swim through the vat is also a satisfactory method. Dipping forks for handling the animals in the vat, keeping the body submerged, and ducking the head may be purchased ready-made or may be made to order by a blacksmith. (Fig. 7.)

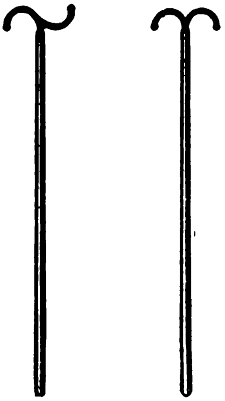


FIG. 7.—Two styles of dipping forks

After the hogs leave the vat they should be held in draining pens or chutes until all surplus dip has drained off them. They should not be driven long distances or compelled to move rapidly within 24 hours or even longer after dipping, as injury may result from too much exercise or overheating shortly after dipping, especially if oil is used.

Hogs should not be dipped in stale dip that has been used and then allowed to stand for a long time. The dip in the vat should be changed as soon as it becomes filthy, regardless of the number of animals that may have been dipped in it. In cleaning the vat the entire contents, including the sediment and foreign matter, should be removed.

DIPS FOR HOGS

In selecting a dip for external parasites of the hog the effectiveness of the dip, the effect on the animals, the cost of materials and labor, and the number of applications necessary to effect eradication are important factors to be considered. The less the number of applications necessary to produce the desired results the greater the saving will be in time, money, and labor. While there are several classes of dips recommended for lice and mange, the oil dips are probably the most economical and dependable for eradicating both kinds of parasites. When oil dip is used no heating equipment is necessary and any kind of reasonably good water may be used. Oil dips do not apparently injure hogs if the freshly oiled animals receive proper care and attention but this does not apply to other species of domesticated animals.

OIL DIPS

The most effective remedies for lice and mange of hogs are natural crude petroleum and some of the oils derived from crude oil. Unprocessed crude oil is an excellent dip for hogs, but it is difficult to obtain and is more expensive than some of the processed oils. Processed crude oil from which gasoline and other light oils have been removed is commonly used and is effective in eradicating mange as well as lice. The thick residue left after the lubricating oils have been extracted is not suitable as a dip. Lubricating oil is also effective in eradicating lice and mange. Oils drained from crank cases of gasoline and other motors are commonly and successfully used for treating hogs. They are usually available and can be purchased at low cost.

Small quantities of distillate are sometimes added to fuel oil and the product sold at a high price as a special oil having a high degree of efficacy in eradicating mange and lice. The effectiveness of fuel oil for mange is increased by adding distillate or kerosene in the proportion of about 1 gallon to each 10 gallons of fuel oil. Heavy processed oils should be diluted with distillate until they flow freely from the container at the usual dipping temperature, but the maximum quantity of distillate added should not exceed 20 per cent. There are also on the market several proprietary brands of crude-petroleum dip, consisting of processed crude oil to which other ingredients have been added. They usually are effective but cost more than the unmedicated crude oil.

In dipping hogs in crude-petroleum dip, fill the vat with water to within about 6 or 8 inches of the dip line, after which add the oil. The oil floats on the water, forming a layer from 6 to 8 inches deep, depending on the quantity added, and as the hogs swim through the vat their bodies become coated with the oil. The oil dips are used cold, and one dipping usually is sufficient to eradicate lice or mange. When crude-oil dip is used it is not necessary to retard the progress of the animals through the vat, as their bodies become coated when they swim directly through.

LIME-SULPHUR DIP

Lime-sulphur dip is effective in eradicating hog mange when four or more dippings are given with an interval of six or seven days between dippings. It is not effective against hog lice. In dipping hogs for mange the lime-sulphur dip should be used warm. The temperature of the dip while the animals are in it should be maintained at from 95° to 100° F. and visibly affected animals should be held in the dip three minutes.

Lime-sulphur dip is made in the proportion of 12 pounds of unslaked lime (or 16 pounds of commercial hydrated lime) and 24 pounds of flowers of sulphur to 100 gallons of water. The lime and sulphur should be weighed and the water measured; do not trust to guesswork. Slake the lime in a shallow water-tight box or tank and add water enough to form a thin paste. Sift the sulphur into the paste and mix well with a broad hoe until a mixture of about the consistence of mortar is formed, adding water as required. Put the mixture into 30 gallons of boiling water, adding slowly so as not to interrupt the boiling, and boil until the sulphur disappears from the surface. The boiling should be continued from 1½ to 2 hours without cessation and the mixture stirred to prevent settling and caking on the bottom. When the sulphur has disappeared from the surface and the mixture is of a chocolate or dark-amber color the boiling should be discontinued.

The contents of the boiling tank should be drawn off or dipped out and placed in the settling tank and allowed to stand until all solids have settled to the bottom and the liquid is clear. The use of some sort of settling tank provided with a bunghole is an absolute necessity, unless the boiler is so arranged that it may be used for both boiling and settling. An ordinary water-tight barrel will serve very well for a settling tank at a small vat. A settling tank of any kind should have an outlet at least 4 inches from the bottom in order that the clear liquid may be drawn off without its becoming mixed with any of the sediment. Drawing off the liquid as indicated above has an advantage over dipping it out, for the reason that in the latter case the liquid is stirred more or less and mixed with the sediment. The prime object is to get the clear liquid without any sediment; the latter under no circumstances should be allowed in the dipping vat, as it may injure the animals.

When the sediment has fully settled draw off the liquid into the dipping vat and add warm water enough to make a total of 100 gallons of dip. When mixed and cooked as specified above, the concentrate is three and one-third times the strength required for the dip in the vat, so that to every 30 gallons of such concentrate 70 gallons of warm water should be added to make a dip of the required strength.

In preparing lime-sulphur dip in large quantities several hundred gallons of concentrate are often made at one time in a single large cooking tank. The quantity made at one boiling is limited only by the facilities at hand. If the boiling tank is of sufficient capacity, a large enough quantity of dip should be cooked at one time to dip the herd. The quantity of mixture in the cooking tank may be varied at will, but the proportions of the various ingredients should not be altered.

Proprietary brands of lime-sulphur dip may be purchased, and many of them are equal to or even better than the homemade product. Ready-prepared dips should be diluted and used in accordance with instructions on the container.

COAL-TAR-CREOSOTE DIPS

The coal-tar-creosote dips when properly used in soft water are fairly effective in eradicating hog lice if two or more dippings are given with an interval of 15 or 16 days between dippings. This is necessary because the first dipping does not destroy the eggs. These dips have not proved to be dependable remedies for mange. They may be used cold or warm, but the temperature of the dip while the hogs are in it should not exceed 95° F.

These dips are sold under many different trade names, and the principal ingredient is so-called creosote oil which is made soluble in or miscible with water by means of soap. In the undiluted coal-tar-creosote dips, especially in cold weather, a separation of naphthalene and other constituents of the dip may occur. Care should be taken, therefore, to see that the dip is homogeneous in character before using any portion of it. These dips should be diluted for use in accordance with the directions given on the containers.

ARSENICAL DIP

The arsenical dip as used for eradicating cattle ticks in the Southern States is an effective remedy for hog mange when four dippings are given with intervals of six or seven days between dippings. As crude-petroleum dip is much more economical and effective, the use of arsenical dip for hogs is not recommended except when a farmer in the southern tick area may have a few infected hogs that he can dip in a cattle vat.

CONSTRUCTION OF HOG WALLOWS

Hog wallows should be built on ground having good drainage and the surface of the ground should be graded so that there will be no depressions in which water may form pools. When shallow pools or mudholes are accessible the hogs seem to prefer them to any other kind of wallow. It is necessary, therefore, to locate the wallow and arrange the pens so that during treatment the hogs will not have access to any wallows except the one designed for the purpose.

The style of wallow commonly used is shown on the front cover. It may be constructed of either concrete or lumber, the former being preferable because it is more durable and in the long run more economical.

The length and breadth of the wallow may vary, depending upon the individual taste of the owner and the number of hogs kept on the farm. While it is an advantage to have the wallow large enough to accommodate the entire herd at one time, it is not necessary, because all the hogs usually do not visit the wallow at the same time. A wallow of the style and size shown in the plans (fig. 8) will easily accommodate a herd of 20 hogs of various ages.

The top of the side and end walls should extend at least 4 inches above the surface of the ground to prevent surface water from running into the wallow. The entrance and exit incline should have a gradual, easy slope, so that the hogs may safely enter and leave the wallow. To prevent slipping, the concrete floor of the incline should be roughened with a broom soon after it is laid and grooves made in it with a bar, or bricks may be set on edge in the concrete to form cleats or toe holds.

In the Northern States, where the winters are cold, the side and end walls usually are extended into the ground below the frost line to prevent the heaving and cracking of the concrete. In such cases a tar-filled joint is made where the floor joins the walls. The walls and floors should be reinforced with heavy woven fence wire. Place the woven wire in the forms so that it will be embedded in the center of the walls. In building the floor and exit incline, lay the woven wire on top of a 3-inch layer of concrete and cover with a layer of equal thickness.

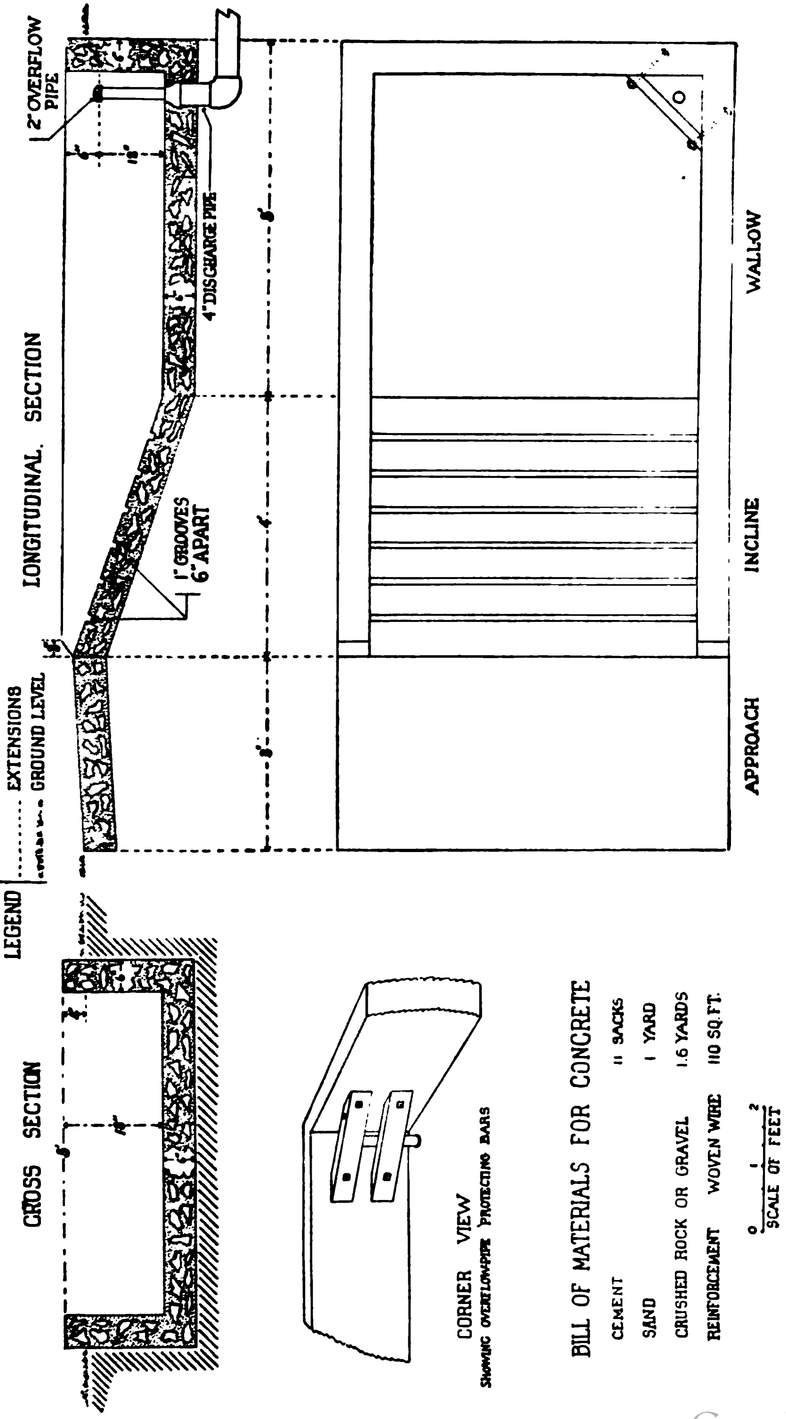


Fig. 8.—Plan of hog wallow—concrete construction

The system commonly used for draining hog wallows is shown in the plans (fig. 8). The overflow pipe which connects with a discharge pipe acts as a plug when it is screwed into its threaded connection at the floor level. To drain the wallow unscrew the overflow pipe at the floor level. The overflow pipe should be protected so that hogs can not rub against it. This may be done by bolting two pieces of scantling across the corner, as shown in the plans. The bolts and pipe connections should be placed in position before the concrete is laid. The approach to the entrance end of the wallow should be paved with concrete or stone to prevent the forming of mudholes and to protect the ground supporting the floor of the incline.

The general instructions concerning excavations, forms, etc., for dipping vats are applicable to hog wallows and the concrete should be prepared and laid in the same manner.

CONSTRUCTION OF DIPPING PLANTS

Small herds of hogs such as are kept on the average farm may be dipped in a portable galvanized-iron hog vat, which can be purchased ready-made and answers the purpose very well. (See fig. 9.) In setting the vat an excavation should be made the dimensions of which slightly exceed the outside dimensions of the vat, except the depth, which should be less, so that when the vat is set in the trench the top may extend about 6 inches above the surface of the ground. A crowding chute and a running chute ending in a slide board at the intake end of the vat should be provided and a draining pen or chute should join the vat at the exit or sloping end.

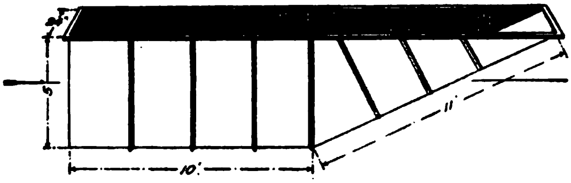


FIG. 9.—Portable galvanized-iron dipping vat

On farms where large numbers of hogs are raised or fed, a permanent dipping plant is more satisfactory and in the long run more economical. Plans for a dipping plant are shown as Figure 10.

SELECTING A LOCATION

In selecting a location for a dipping plant the fact that animals work better upgrade should be considered, and the corrals and running chute should slope up to the entrance end of the vat. The vat should be on level ground, preferably extending north and south, with the entrance at the south and the exit at the north, as it has been observed that animals work better when not facing the sun. A considerable quantity of water is used in dipping, so the dipping plant should be close to an adequate supply. The vat, however, should not be built on low, marshy land or where flood waters overflow.

PENS AND CHUTES

The receiving corrals or pens into which the hogs are driven preparatory to dipping should have an opening directly into the forcing or crowding chute. If the draining pens are not large enough to hold the entire herd, holding pens should be provided for the freshly dipped hogs.

The running chute should be at least 20 feet long and preferably curved to prevent the approaching animals from seeing the vat. The width may vary from 18 to 22 inches, depending on the size of the animals, and the sides should be tight-boarded. The height of the chute should be about 40 inches, or high enough to keep the animals from jumping over the sides, but sufficiently low so that the men stationed along the sides to keep the animals moving may work over the top. Hogs will work better in the chute if it slants upward to the slide board.

When hogs emerge from the vat they carry out some of the dip, which runs off their bodies very rapidly. This dip should be saved and returned to the vat, not only because it may be used over and over again but because if it is allowed to drip off in the holding corrals it will collect into pools, from which the animals may drink with possibly injurious results, and even if no hogs are injured in that way the mudholes which form are highly objectionable. Accordingly draining pens with water-tight floors sloping toward the vat or settling wells should be provided to catch and return the dip to the vat. The size shown in the plans may be increased or decreased to correspond to the length of the vat. The floors of the pens may be made of lumber or concrete and should have settling wells or water traps to prevent rain from running into the vat and diluting the dip. A design for a settling well is shown in Figure 10.

In constructing the draining pens of concrete it is advisable to build the outer walls in the same manner as the foundations for a house, except that they are to be 6 inches thick. The space inside the walls is to be filled with gravel or other suitable materials to the required height and the sloping floors laid on the tamped gravel. To prevent slipping, the concrete floors should be roughened with a stiff broom while the concrete is soft, or a coat of pebble dash may be applied. If wooden floors are used they should be double, with a layer of tar paper between the two floors. Rough lumber may be used for the lower floor but the top one should be of matched boards 1 inch thick. Cleats should be nailed on the floor to prevent the hogs from slipping.

THE DIPPING VAT

The dipping vat may be constructed of either concrete or lumber, the former being preferable, because when properly made the vat is more durable and in many other ways more satisfactory than when made of lumber. The sides may be perpendicular if desired, but sloping sides are generally considered to be more desirable than perpendicular ones.

The length of the vat may vary from 20 to 40 feet, depending on the number of hogs to be dipped. The top may extend from 9 to 18 inches above the surface of the ground, or may be flush with it, but the former kind affords better conditions for handling the hogs than one flush with the ground. In either style the ground should be graded up to provide a well-drained path along each side of the vat.

The bottom width of the vat with sloping sides may vary from 6 to 12 inches or even more if desired. The slide board should be made of or covered with a smooth-surfaced material, such as planed lumber, sheet metal, or well-troweled concrete. In order that the exit incline or crawling board may not be too steep for hogs to climb up easily the lower end usually is raised about 12 inches above the floor of the vat. (See fig. 10.) A false floor made of lumber and having cross cleats to prevent slipping may be bolted to the concrete floor of the exit incline, or bricks set on edge in the concrete will answer the same purpose.

If permanent pipes are used for conducting water and dip to the vat they should be laid so as not to act as obstacles to the men working along the vat, but they should enter the vat above the dip line so that any leakage may be detected. There should be no obstruction in the paths along both sides of the vat; neither should there be over the top of the vat any crosspieces that may interfere with the proper handling of the hogs while they are in the dip.

In building wooden vats, if softwood is used for the frame timbers they should be 6 by 6 inches, but if hardwood is used 4 by 4 inch timbers are sufficiently large for the purpose. Cedar posts make good framing timbers, as they do not rot rapidly. Matched planks, 2 inches thick, should be used in building the vat, and they should be beveled so that all joints and seams may be properly calked with oakum and rosin, or similar material.

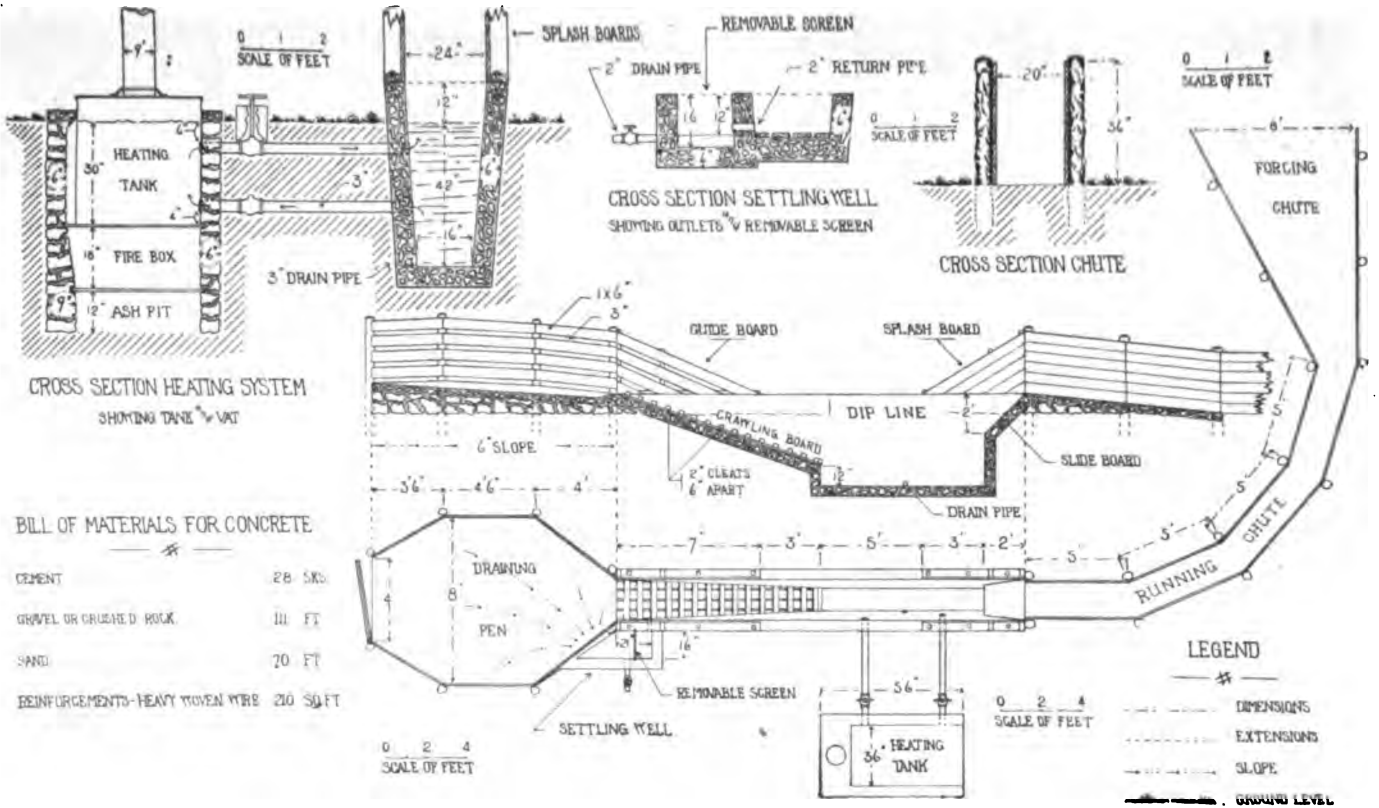
A CONCRETE VAT

The trench for a concrete vat should be excavated so that the inside dimensions correspond to the outside dimensions of the completed vat. If the sides of the trench are reasonably firm they may be used for the outer walls of the form, but in all cases in which the vat is extended above the surface of the ground it is necessary to build forms extending from the ground surface to the top of the vat. If the soil is sandy, or the walls cave in, it will be necessary to use outer forms, in which case the trench should be wide enough for them.

The forms usually are made of 1-inch boards and 2 by 4 inch braces, and as a supply of lumber usually is necessary for the corrals and chutes some of it may be used for the forms and afterwards for constructing corrals and chutes.

All bolts and the drain and other pipes should be placed in position in the forms before the concrete is laid. The concrete should be reinforced with heavy woven wire, and the reinforcements should be placed properly in the forms, so that they may be embedded in the middle of the walls.

The concrete for dipping vats should be made of 1 part of Portland cement by measure, 2½ parts of sand, and 4 parts of screened gravel or crushed stone. The sand should be coarse, clean, and free from foreign matter. The crushed stone or gravel may vary in size from one-quarter to 1 inch in diameter. The mixing should be done on a smooth, tight platform and the sand and rock measured separately in a bottomless box 2 feet long, 2 feet wide, and 1 foot deep, having a capacity of 4 cubic feet. For the 2½ cubic feet mark the inside of the box 7½ inches up from the bottom. Each sack of Portland cement is considered to be equal to 1 cubic foot. Mix the sand and



BILL OF MATERIALS FOR CONCRETE

CEMENT	28 SKS
GRAVEL OR CRUSHED ROCK	111 FT
SAND	70 FT
REINFORCEMENTS-HEAVY WOVEN WIRE	210 SQ.FT

FIG. 10.—Plan of hog-dipping vat concrete vat

cement thoroughly, add the crushed stone (previously drenched with water), and mix the whole mass by turning it several times with shovels. Then add water in a depression made in the center of the pile and mix well by turning several times with shovels, adding water enough during the mixing to make a "quaky" or thin, jellylike mixture.

The placing of the concrete in the forms should be commenced as soon as the mixing is finished. The floor and exit end should be laid first and the concrete well tamped. In filling the forms the concrete should be well settled into place by spading rather than by tamping, and special attention should be given to spading next to the inside forms to force the coarse particles back and allow the sand-cement mortar to form a dense, water-tight surface. An old hoe straightened out makes a good spading tool, as the handle is long enough to reach the bottom of the forms. If it is necessary to stop work for the day before the forms are filled the surface of the concrete in the forms should be roughened with a stick. Just before placing additional concrete wash the roughened surface and paint it with cement and water mixed to the consistence of thick cream. Leave the forms in place two or three days, if possible, and wet the concrete daily. After the forms are removed, dampen the surface of the concrete and apply a finishing coat composed of 1 part of cement and 2 of sand or mix cement and water to the consistence of cream and apply it brushing well to form a smooth surface.

HEATING FACILITIES

Heating equipment in connection with the dipping plant is necessary when crude-petroleum dip is used, but when homem lime-sulphur dip is used it is necessary to provide facilities for coo ing the dip and also for heating it in the vat. The cooking may done in open kettles or tanks, having a fire box under them, or li steam may be piped into them for boiling the dip.

The commonly used system of heating the dip in the vat is to pi live steam directly into the liquid from a steam boiler. The ste pipes usually are extended along the floor of the vat at least tw thirds the length, and are provided with openings for the escape steam into the dip. When the open-tank heating system, shown the plans for a concrete vat, is used, settling wells are not necessar as the heating tank answers the purpose of a settling well.

U. S. GOVERNMENT PRINTING OFFICE: 1931

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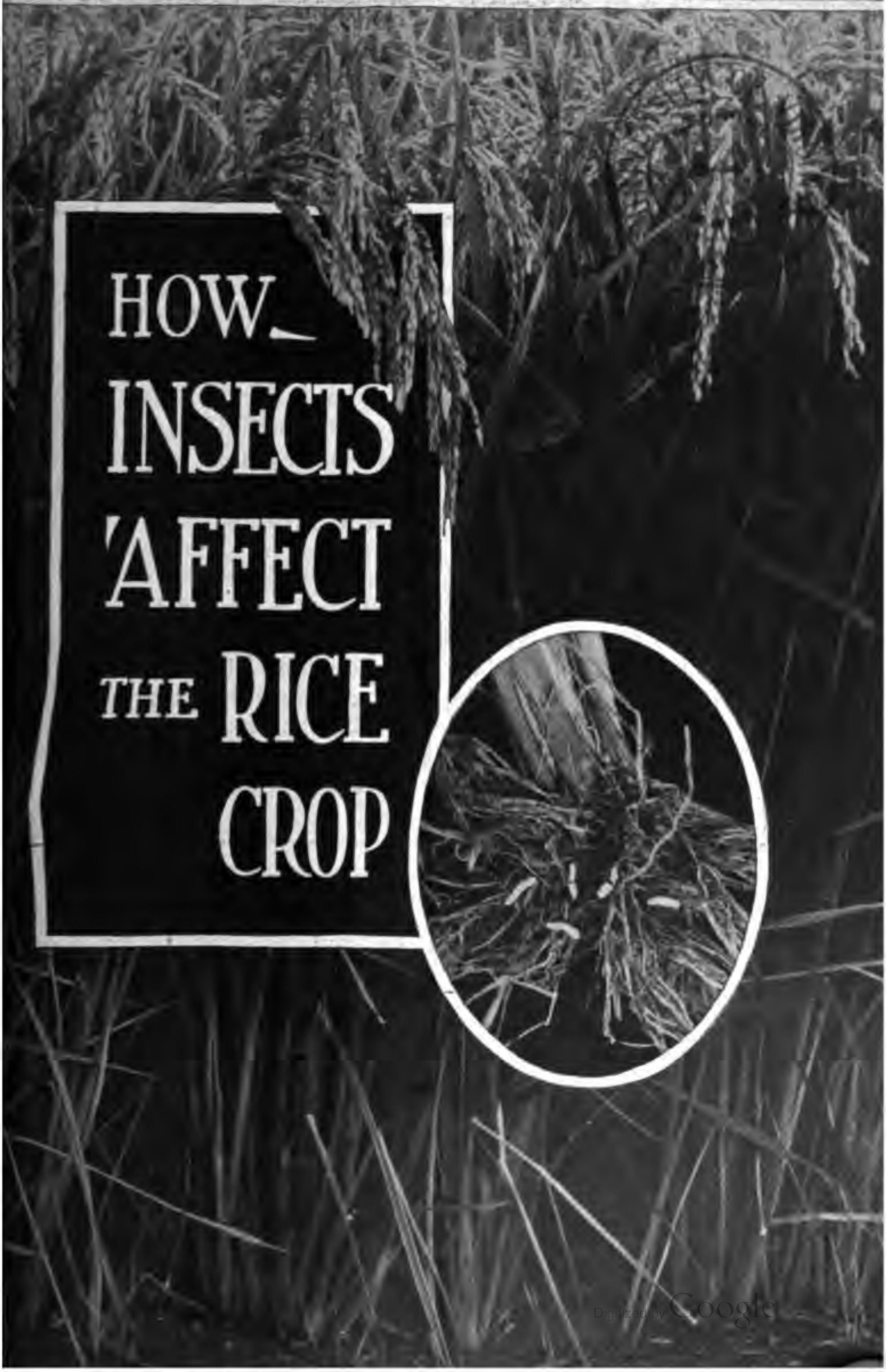
FARMERS' BULLETIN 1086
UNITED STATES DEPARTMENT OF AGRICULTURE

HOW INSECTS AFFECT THE RICE CROP



THE slender, milk-white grub or "maggot" of the rice water-weevil lives on the roots of rice, and whether it feeds little or much upon them, kills practically all the roots that it attacks. This pruning of the roots weakens the rice plant and often kills it.

Another enemy of this staple crop of the South is the stink bug, which sucks the juices from the soft grains of rice.

The fall army worm, when it becomes abundant, works great havoc in its attack upon young rice. Other insects also, such as the rice stalk-borer, infest the rice field, and the rice planter must constantly guard his crop against them.

This bulletin tells when to plant, and when to flood and drain the fields in order to reduce the numbers of these pests, and recommends other measures that will prevent attack by the many minor species of insects which normally breed in and near rice fields.

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief
Washington, D. C. March, 1920

A1.9:1086

HOW INSECTS AFFECT THE RICE CROP.[1]

J. L. Webb,
Entomological Assistant, Southern Field Crop Insect Investigations.

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SOME INSECTS INFEST RICE FIELDS ALMOST EVERY YEAR.

EVERY great staple crop when grown in abundance in large areas becomes affected by many serious pests. This is sometimes because of the greater succulence of cultivated crops and sometimes because the insects of the neighborhood which normally would attack native plants are forced either to starve or adapt themselves to the plant growth which is most numerous. The result is that every few years some "new pest" becomes serious on one of our staple crops. This adaptation often happens very suddenly, as when new land is broken and cultivated and all the native insects are at once forced to attack the new crop.

Even rice, with its unusual system of agriculture, occasionally is very seriously affected by insect pests. For example, a new rice section was opened up in Texas a few years ago and a billbug,[2] which never before had been collected on any plant and was considered very rare, suddenly became serious and destroyed large plantings. But it disappeared as suddenly when the new rice was flooded and never has been heard of since.

Some enemies of rice, however, are to be found in the fields almost every year and at times cause great losses to the crop. These will be discussed in greater detail in the following pages.

---

[1] The insects discussed in the following pages are fairly common in the rice fields of Louisiana, Texas, and Arkansas, but have not yet been found in the rice fields of California.

[2] (*Calendra*) *Sphenophorus oblitus* Lec.

THE RICE WATER-WEEVIL LIVES ON THE ROOTS.

Rice roots are attacked by the "maggot," or larva, of the water weevil,[1] which is rather generally distributed throughout the rice belt. The amount of damage done yearly to the rice crop by the rice water-weevil is extremely hard to estimate. In most cases no rice is killed outright, and yet practically every rice field is infested to a greater or less degree.

The effect of the weevil attack is the pruning off of the roots near the base of the stalk. In severe attacks all the roots may be cut off, in others only a few. Where the pruning is not too severe, the rice plant promptly throws out new roots, continues to live, and will mature. In extreme cases the rice plants are killed and the loss is then easier to estimate. In general the loss from this source is considerable, and well worth active efforts in the way of prevention or elimination.

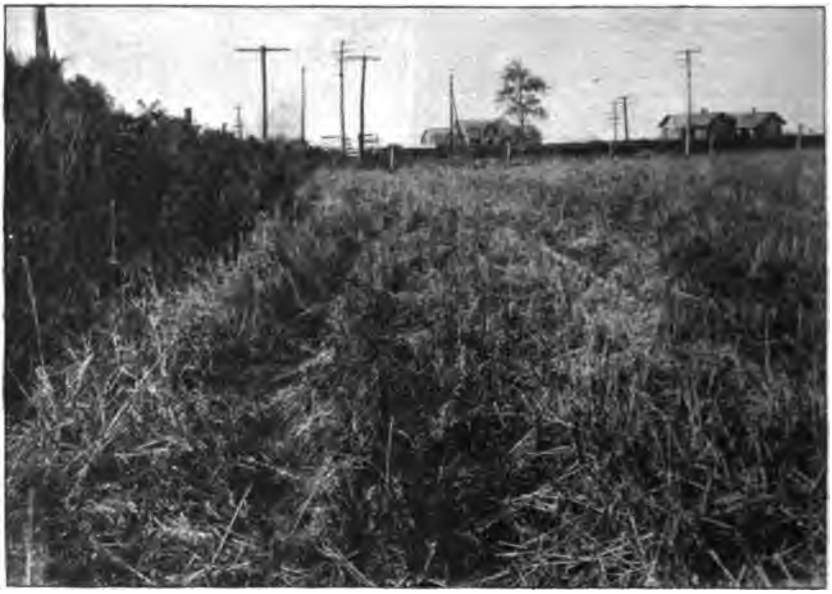

FIG. 1.—Overwintering quarters of the rice water-weevil.

THE WEEVIL.

The adult weevil passes the winter in dead grass (fig. 1), especially grass that is matted down upon the ground. In order to find the weevils in hibernation, that is, in their winter sleep, the grass must be lifted up and thoroughly shaken out, causing them to fall to the ground. Even then close examination is necessary in order to distinguish them, as their general color is much the same as that of the dry grass. Great numbers of weevils pass the winter in the dried grass.

---

[1] *Lissorhoptrus simplex* Say.

In southern Louisiana the weevils begin to come out from their winter quarters rather early. The earliest date upon which an adult has been observed to be active is March 25. The latest date upon which adults were found dormant was June 26. This gives a period of three months for the emergence of the entire generation of overwintering individuals.

The adult weevils are usually not noticed in spring until the first flooding of the rice fields. Then almost immediately they are to be found swimming about in the water among the rice plants or resting upon the leaves above water. Sometimes they apparently rest upon the leaves for hours, but when touched promptly "play possum," fall to the water, and swim away. They appear to be equally at home in water and out of it. It is impossible, however, for them to breed in any but water plants.

Feeding.—The first injury to the rice plant occurs upon the leaves and is caused by the feeding of adult weevils just before and after egg deposition. This injury takes the form of longitudinal feeding scars, the weevil eating out a furrow in the leaf just as broad as the spread of the mandibles. Only the thin outer skin of the underside is left. Little real damage is caused in this way, but the work is very characteristic of this species.

Egg laying.—Mating and egg laying apparently commence shortly after the adults reach the flooded fields of rice. When ready to deposit an egg the adult female crawls down the rice stem beneath the water and surface of the soil to one of the principal roots. Here she inserts the ovipositor, apparently by merely forcing the tip of this organ through the epidermis or outer layer of skin of the root. The egg is then placed longitudinally just under the epidermis. It is cylindrical, pearly white, and about one thirty-second of an inch in length. It is three or four times as long as broad and barely visible to the naked eye. From the egg in a few days there hatches a minute legless grub or larva.

THE LARVA.

For the first few days of its existence the larva remains within the root in which it was hatched, feeding upon the inner root tissues and increasing in size. It advances along the root longitudinally, eating out a passageway as it goes. By the time it has exhausted the nutritive qualities of this first root it is large enough to proceed farther, and goes to another root, undeterred by the surrounding mud. (See fig. 2.) Whether it feeds little or much upon successive roots, practically all roots attacked are killed. Often several larvæ are found among the roots of a single plant and work great destruction there. At this stage many of the larvæ are easily disclosed by pulling up infested rice plants and shaking the roots in water until washed clean of mud. (See fig. 3.) Some of the larvæ float on the surface of the water, others sink to the bottom. When the roots of a rice plant are severely injured the leaves turn yellow, and may even fall over upon the surface of the water.[1]

When full grown the larva is from one-fourth to one-half inch in length, very slender, and milk white.

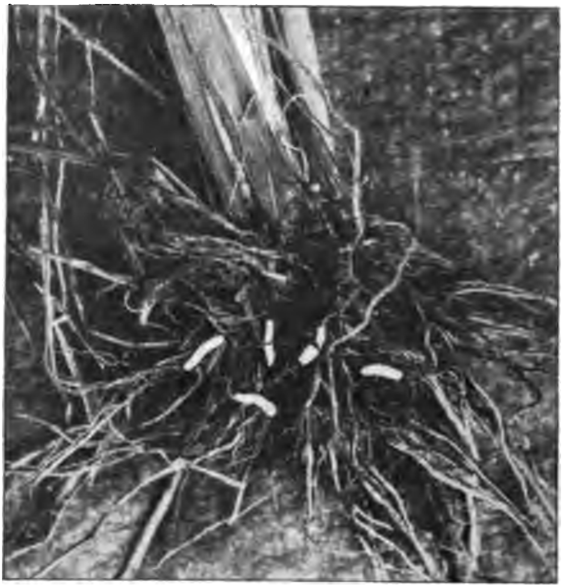

FIG. 2.—Rice root "maggots" among the roots of a rice plant.

THE PUPA.

In preparation for the change to the pupal or resting stage, the larva gathers about itself an egg-shaped mass of dirt, which it attaches to one of the healthy rice roots. (See fig. 4.) The outside of this cell is uniformly even and oval in shape, and is composed of dirt and a secretion from the weevil larva which makes it impervious to water. Within the pupal cell, safe from water, the larva spins a thin silken cocoon about itself as if to make itself doubly secure, for it is delicate and helpless while it undergoes, during its pupal period, the difficult transformation into the adult-beetle stage. As many as 15 pupal cells have been found attached to the roots of one rice plant.

The pupa shows somewhat the form of the adult, but it is entirely white, like the larva. The duration of the pupal stage is probably from one to two weeks. When fully mature the adult breaks through the wall of the pupal cell, crawls up the root to which the pupal cell was attached, and so escapes to the open air.

LENGTH OF LIFE CYCLE.

The length of time the insect spends in each of these four stages is not definitely known; however, the time from deposition of the egg to the young adult stage in the spring has been determined approximately. In a plot of rice which was first flooded on June 1, 1912, a young adult was found in a pupa case on July 8, 1912. The egg could not have been deposited before the rice was flooded, and, supposing it to have been deposited the first day of flooding (June 1), the time occupied in reaching the adult stage by July 8 was 38 days, or 5½ weeks. It is, of course, possible that even less time than this was actually occupied by the insect in passing through the different stages.

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[1] Tucker, E. S., The rice water weevil and methods for its control. U. S. Dept. Agr. Bur. Ent. Circ. 152, 1912.

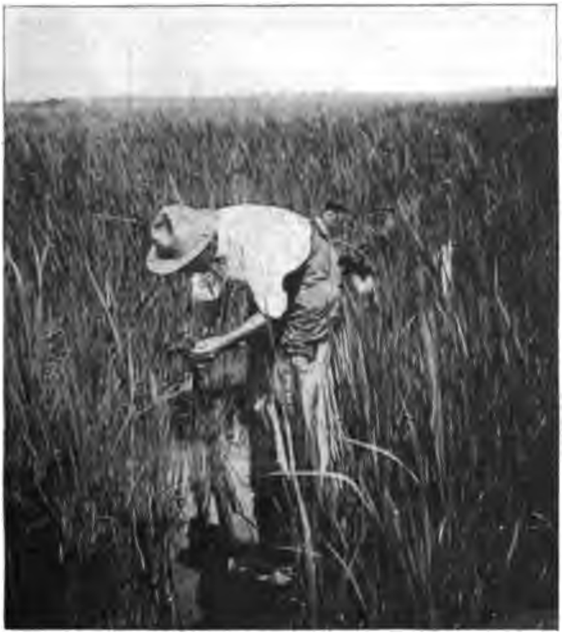

FIG. 3.—Examining rice roots, after first washing off the mud, for root "maggots."

CONTROL BY DRAINAGE.

Careful experiments have demonstrated that drainage is the safest remedy for the rice water-weevil. The proper time to commence drainage of the fields is from two and one-half to three weeks after the first flooding, while the larvæ are still young. Drainage should continue for a period of two weeks. A shorter period of drainage will not kill the larvæ, and a longer period will injure the rice. Planters should not wait until the rice begins to turn yellow before commencing to drain. The damage is practically all done by that time, and the rice needs water to enable it to throw out new roots and recover from the attack of the insect.

THE STINK BUG INJURES THE YIELD.

Rice growers are familiar with an elongate, straw-colored bug, with mouth parts fitted for piercing and sucking, which is known as the stink bug.[1] As the name indicates, it has a very offensive odor which becomes apparent when one handles the insect. Its life history in relation to the rice plant has not been worked out in detail. Its injury to this crop is largely confined to late summer and early fall when the rice heads are forming, the mature and nearly mature bugs attacking the soft grains of rice, sucking the juices from them by means of the beak, which lies concealed under the body when at rest.

---

[1] *Oebalus pugnax* Fab.

A good deal of the injury and loss from this source can no doubt be avoided by getting the crop in early in the spring so as to bring it to maturity before the bugs become abundant in the fall. A wise precaution is to keep down weed growth surrounding the fields, which reduces the food supply during the summer for the younger stages, and cuts off the food supply for the adults after the rice is harvested. Fall weed cutting is especially important for this reason.

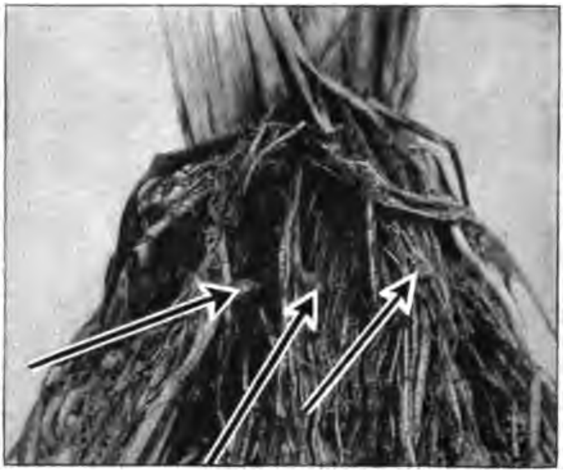

FIG. 4.—Pupal cells of the rice water-weevil attached to rice roots.

THE FALL ARMY WORM OR SOUTHERN GRASS WORM INJURES RICE.

Southern planters are bothered almost every year with the grass worm,[1] and in some years the pest is a veritable plague. This insect, which resembles the true army worm of the North, and attacks practically all kinds of vegetation, occasionally becomes abundant in rice fields in the spring before the rice is flooded. Unless prompt measures are taken it soon works great havoc, as it is a voracious feeder, and the young rice seems to be especially palatable to it. It is easily controlled by the simple method of flooding the fields and drowning out the worms. After flooding there is little danger of an invasion, as it is impossible for the worms to reach the plants through the water surrounding the fields.

THE RICE STALK-BORER KILLS THE PLANT.

After the rice has headed out, there will be found in most fields, if one looks closely, occasional single white heads among the surrounding green or yellowish ones. An examination of the stalk below the head will usually reveal the larva or pupa of the stalk borer[2] within the stalk. The larva feeds on the inner stalk and the head dies before maturity.

---

[1] *Laphyghma frugiperda* S. & A.

[2] *Chilo plejadellus* Zincken.

The adult form of this insect is an elongated moth of a pale yellow color with golden patches and scales, having a row of black dots at the end of each front wing. The eggs are evidently laid on the leaves, and on hatching the larva crawls down and bores into the stalk.

The appearance of infested plants resembles somewhat that of diseased plants, but in the case of attack by the borer some of the leaves, as well as the head, usually will be found dry and withered, which is not the case in diseased heads.

The damage from the rice stalk-borer is slight. It has been suggested that, in case of heavy infestations, the best way to rid a plantation of the borer is after harvest to cut, as close to the ground as possible, the stubble, volunteer rice, and weeds, and to burn them thoroughly in some safe place.

MISCELLANEOUS INSECTS WHICH AT TIMES INJURE THE RICE CROP.

The most destructive insect enemies of the rice crop already have been mentioned. Several others, not so generally present, occasionally increase in numbers to such an extent as to cause injury to the crop. Among them are the Southern corn rootworm,[1] which sometimes attacks the rice seed after it is planted, completely destroying its power to produce a plant.

A black beetle, which also attacks corn, known as the rough-headed corn stalk-borer,[2] is sometimes found in rice fields. It attacks the main stem of the rice plant just above the roots, shredding it and causing the plant to die.

In addition to the above-mentioned insects, various sucking bugs, caterpillars, grasshoppers, and leafhoppers prey upon the crop, although as a usual thing damage by them is so slight as to escape notice.

THE BEST METHODS OF INSECT CONTROL IN RICE FIELDS.

(1) Plow fields in fall previous to planting time to kill pests in the soil. In the case of sod land, cultivate thoroughly in the fall. If fall plowing is not done, burn off all vegetation during winter to destroy pests overwintering in the dead grass and weeds.

(2) Three weeks after first flooding, drain fields for two weeks to prevent damage by "root maggots."

(3) In case of caterpillar or worm attack upon the leaves, flood the field immediately.

(4) Keep down all weed growth around the field and on the levees separating the plats. This will greatly reduce attack by many minor species of insects which normally breed in these weeds.

---

[1] *Diabrotica 12-punctata* Oliv.

[2] (*Ligyrus*) *Euetheola rugiceps* Lec.

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UNITED STATES DEPARTMENT OF AGRICULTURE

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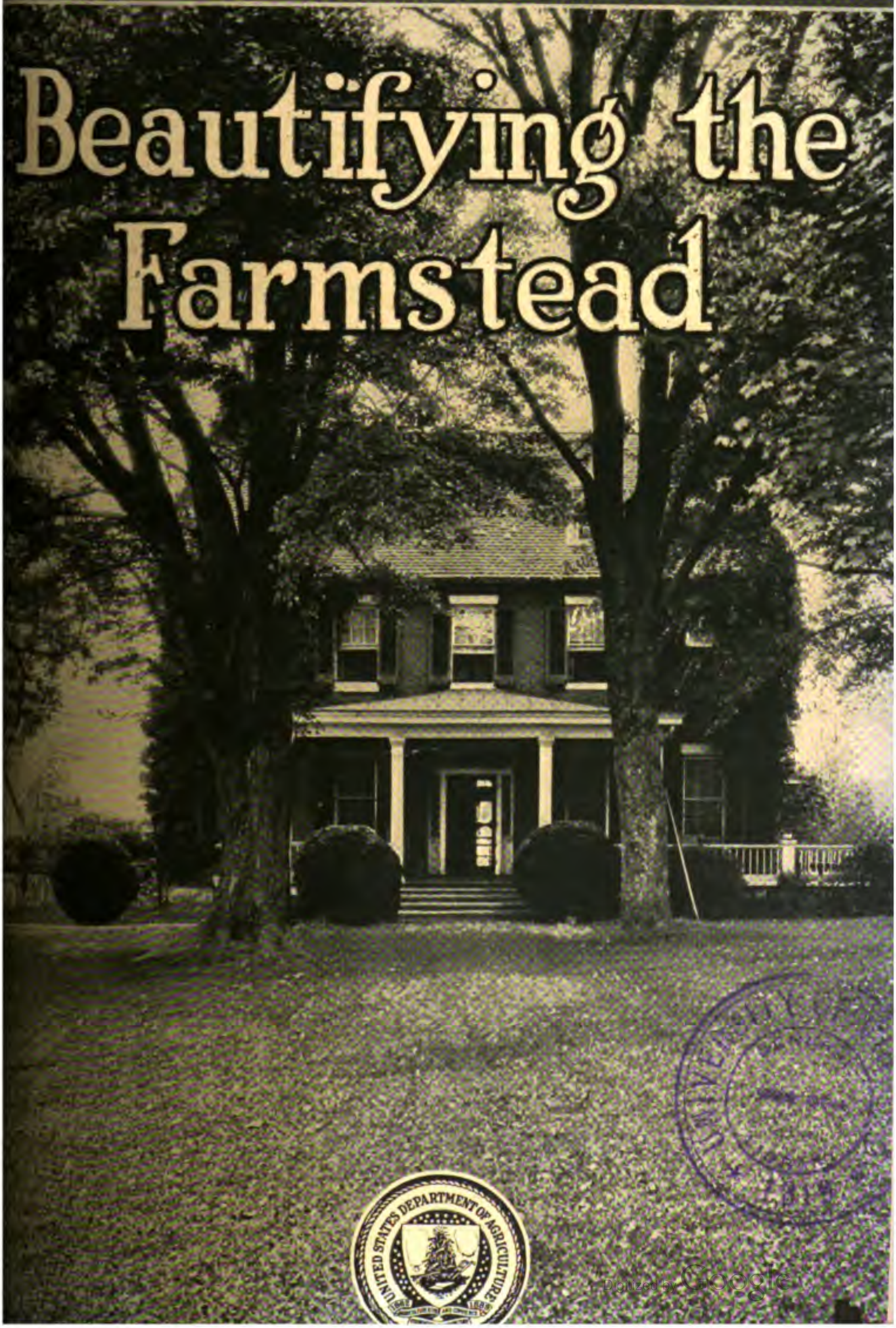
FARMERS' BULLETIN 1087
United States Department of Agriculture

Beautifying the Farmstead



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BEAUTIFYING THE FARMSTEAD.

F. L. MULFORD,
Landscape Gardener, Office of Horticultural and Pomological Investigations.

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NEED OF BEAUTIFYING THE FARMSTEAD.

HOMES are the foundation of a nation. With clean, attractive, pure homes the youth become strong, upright, honorable citizens. Anything that will make the home better will tend to improve citizenship.

The essentials of a good home are a man and woman resolved by their mutual efforts to make this world a better place in which to live and a structure that will protect life and health from undue exposure to the elements. (Fig. 1.) If the dwelling is to be really a home it must be more than a place at which to eat and sleep. (Fig. 2.) It must be for the mature a haven of rest from vexations incident to breadwinning and other serious duties of life and for the young a retreat for the solution of life's problems. Inspiration to better living must be there, incentive to strive diligently for the highest ideals; and to attain these ends, not only must the physical needs of the family be supplied moderately well but the home must be attractive. (Fig. 3.)

The foundation of this attractiveness is love among the members of the household, combined with a right moral, mental, and religious attitude. This attitude may be greatly altered by changed surroundings. Sufficiency of food and exercise with other physical comforts in moderation are conducive to the highest development, while marked deficiency or excess of physical comforts is debilitating. Beauty in every form has an influence for good. Forms of beauty differ greatly in their effect on persons. Children especially are wonderfully affected for good or ill by their surroundings. The greatest influences are probably seldom realized at the time they are exerted.

It is important that the home should be carefully arranged so as to give the most helpful influences. This is well recognized in cities and towns so far as it relates to the arrangement and decoration of the interior of houses, to some extent to the house itself, and to a less degree to its surroundings. The purpose of this bulletin is to suggest the importance of improving the surroundings of farm homes and to show how unattractive conditions (fig. 2) may be made attractive (fig. 3) without undue labor or expenditure.

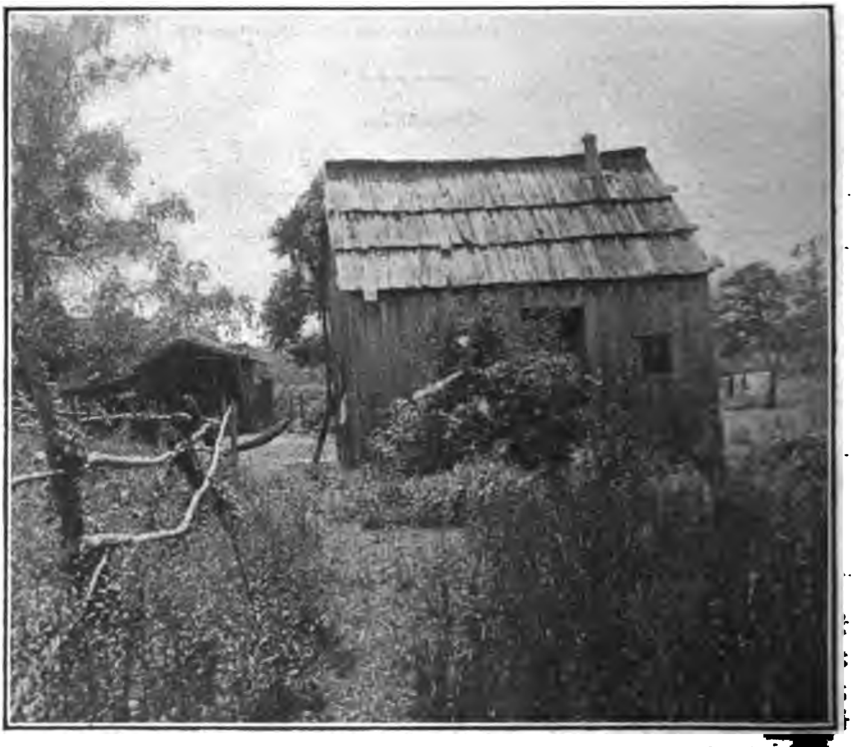

FIG. 1.—A structure that will afford protection from undue exposure to the eleme[illegible]

The poor taste and judgment shown in developing the outward appearance of our homes have left much to be desired. In the colonial days and the early days of the Republic the prevailing style of architecture and planting in both city and country was simple, direct, and attractive. (Fig. 4.) This may have been the result of necessity or the exercise of good taste, probably the latter, in an honest endeavor to meet recognized needs by the most direct methods.

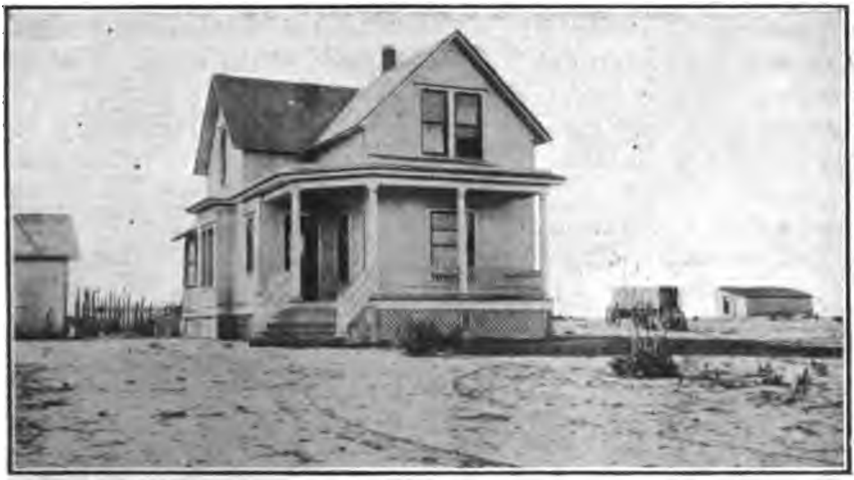

FIG. 2.—A comfortable place to eat and sleep, but not all a home should be. Compare with figure 3.

More recently, styles in city and suburban buildings have changed almost as rapidly as styles in clothing. Apparently the prevalent idea has been to make as much show as possible with the funds at command, with little regard to the real purpose to be served. What is more, the planting of trees, shrubs, and flowering plants has been largely neglected, and city and suburban styles have been

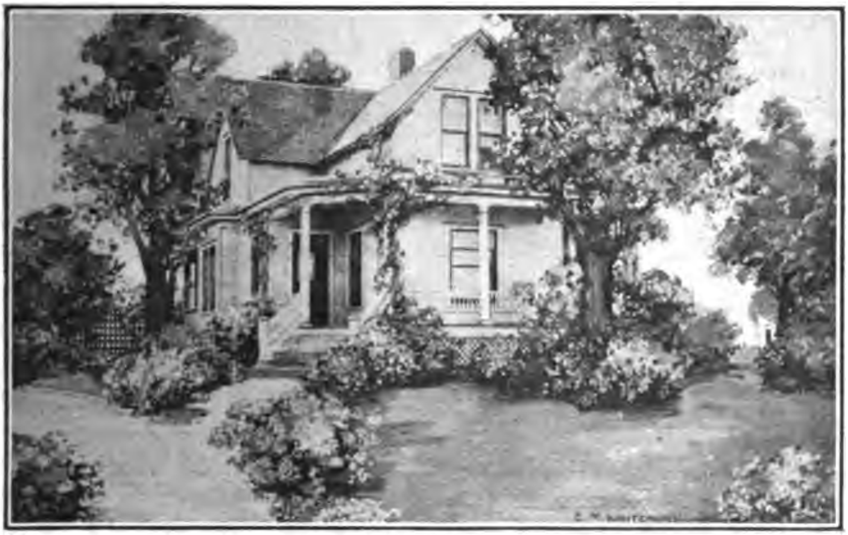

FIG. 3.—The building shown in figure 2 made homelike and attractive by suggested plantings.

copied on the farms whether appropriate or not. (Fig. 5.) Now, however, there is an evident effort to make the style of building harmonize with its needs and location.

The attention attracted by properly located, well-arranged buildings with good plantings is itself evidence of the extent to which these matters have been neglected in all parts of the country. Much thought and money have been expended to provide luxuriously for the physical needs, even to an extent that is harmful rather than beneficial. Little thought has been given to external appearance beyond a show to the community for the money spent.

The application of good taste in beautifying the interior of the home has been more in evidence. Attractive and homelike interiors have been common both in city and country in spite of repeated waves of fashion in interior decoration and inappropriate exteriors.

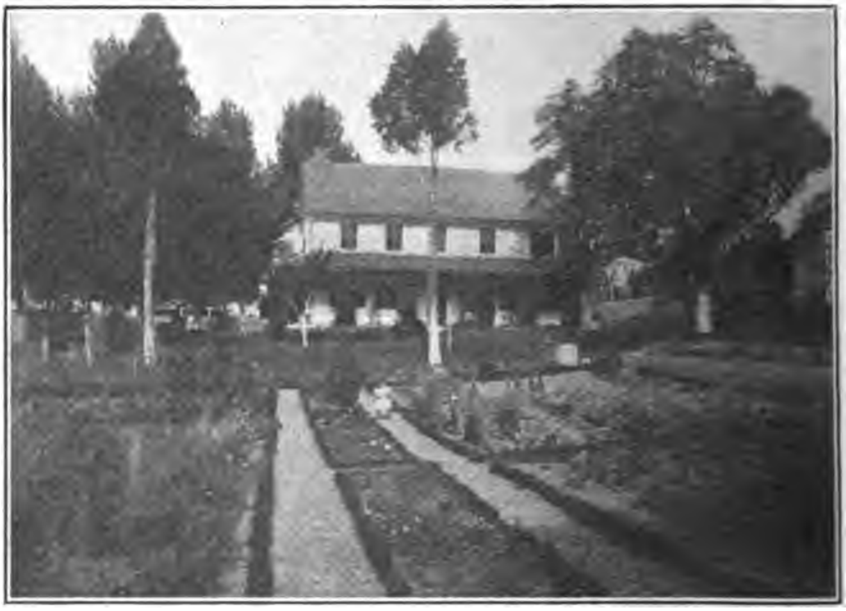

FIG. 4.—A colonial farmhouse.

The efforts of women to make the homes attractive usually include the immediate surroundings of the dwelling. In suburban communities and in cities which are not too closely built up, men are cooperating more and more actively in the development of home grounds and often take the initiative. On the farms the little attention that is given this matter is often contributed solely by the women of the household.

In cities and villages the home and the business are so separated both in place and in character that if the man comes home from his day's labor and puts thought and work on his home surroundings it is a positive relaxation and recreation. On the farm the business and the home are so intertwined and so close together and the character of the day's labor and of the effort to beautify the home surroundings are so nearly parallel that there is not the same relaxation or recreation in the effort. The very closeness of physical relationship between the business and the home make it all the more necessary that the preeminence of the home shall be emphasized in every way possible. If this is not done business will crowd out the home spirit and make life one round of drudgery.

The farm family, because of its comparative remoteness from the turmoil and distractions of the city, has wonderful opportunities to make a real home, while the city family, with its greater temptations to dissipate its energies, has to exercise much restraint to accomplish the same end. Among the opportunities of the farm family is that of beautifying the farmstead, so that it may be more attractive to the occupants. This, in turn, will tend to make both young and old more contented. It will also add materially to the enjoyment of those who pass by and thus incidentally to the selling value of the farm.

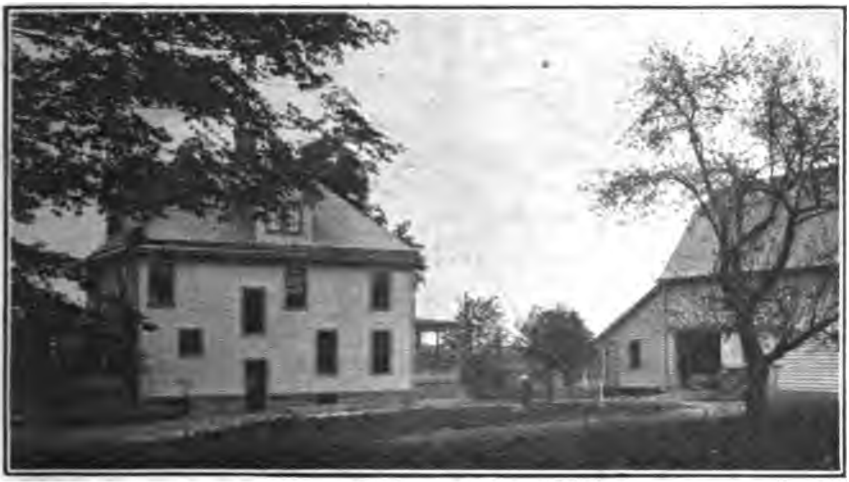

FIG. 5.—A city house in the country.

Neglect of such improvement is usually due to one or more of the following causes: (1) Opinion that it will require too much time and work for upkeep, (2) a feeling that the improvement will be unsuited to farm conditions, (3) a belief that any adequate improvement will be too expensive, (4) indifference, and (5) a lack of understanding of what can be accomplished by expending a little effort in this direction.

DESIRABILITY OF MAKING PLANS FOR IMPROVEMENTS IN ADVANCE.

A farmstead consists of the farm buildings and the land immediately surrounding them that is necessary to their proper use and to the making of the home. Under this definition, not only are the buildings and the approaches from the highway a part of the farmstead, but also the cattle, hog, and chicken yards and the vegetable, fruit, and flower gardens. (Fig. 6.) Because of the intimate relationship between the farm home and the farm business all these things must be taken into account when planning to improve the home surroundings. Not only the house lot but the whole farmstead must be considered.

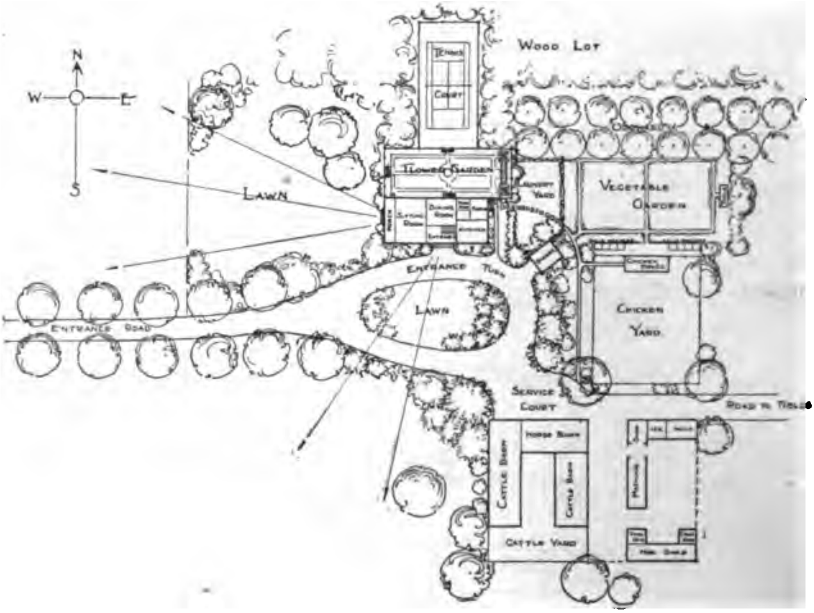

Fig. 6.—A plan for a farmstead where the buildings are back from a north-and-south road.

Before any improvement can be made some idea must be formed as to what should be done. Are any changes in existing buildings, roads, or other permanent features desirable, and, if so, how can they be made, and, after all, will the change really be an improvement? (Figs. 7 and 8.) Such a consideration of the conditions is planning, whether the results are held in the mind of the one doing it or are put upon paper either in the form of written memoranda of the changes to be made or as a drawing showing what is to be done.

In order that the whole family may be interested and thoroughly understand what is being considered and have an opportunity intelligently to offer suggestions, it is desirable that some memoranda be put upon paper. The more complete this is and the more carefully it is worked out, the less is the likelihood of unexpected difficulties arising as the work progresses. It is appropriate to include features that may not be carried out for several years (fig. 9), so these improvements can be made when the time comes without interfering with other features of the plan.

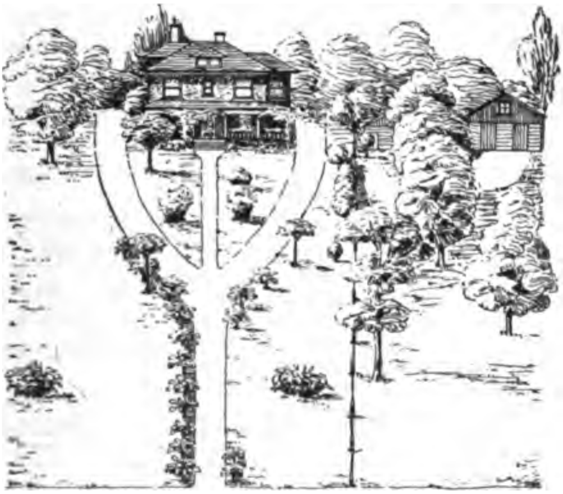

Fig. 7.—Undesirable arrangement of an approach to a farmstead. Compare with figure 8.

When an established place is to be improved it should be studied in the same way as a new place, forgetting all roads and structures, except, possibly, the largest and most expensive buildings. In making the first studies, even these should not be assumed to be incapable of being moved or altered. Then plans should be made which incorporate the buildings as they exist. If the last plans made are not as satisfactory as the original ones, alterations should be considered until a practical compromise is evolved, even though it require changes in permanent features, such as roads and buildings.

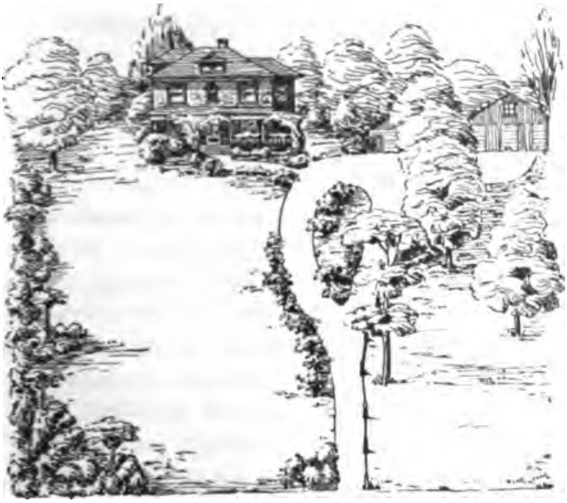

Fig. 8.—A revised design for an approach to the farmstead shown in figure 7.

In planning a new place the first thing to be considered is the approximate location of the principal buildings, with the space they should have about them and the relation of that space and of the buildings to one another. Then the necessary drives and walks, including the approaches to the buildings and all service features, should be located. After this, the detailed plans of the buildings should be worked out to conform to the general scheme, followed finally by the planting suggestions. It is much easier to move a building before the cellar wall is built than after it is up, and much annoyance can be saved by making plans of the grounds and then of the buildings. This holds whether an old place is to be slightly modified or a new place built and whether the work is to be done by the owner or by landscape designers and architects.

It frequently happens that houses and barns are put up without seriously considering their relation to one another or to the means of getting to and from them. Awkward situations often arise even in flat countries from such lack of foresight, while in rough countries almost impossible conditions frequently occur from such neglect. To prevent difficulties it is necessary to plan the grounds carefully before building and then make the building plans to suit. In this connection it is essential to study thoroughly the land conditions as to elevation, slopes, and drainage.[1] Also consideration should be given to the desirability of the different points of the compass as exposures for the important rooms of the home or for facing the different buildings or the yards adjoining them. This is called "orientation" by architects and engineers. In addition, it is necessary to decide whether the development is to be simple and inexpensive or elab-

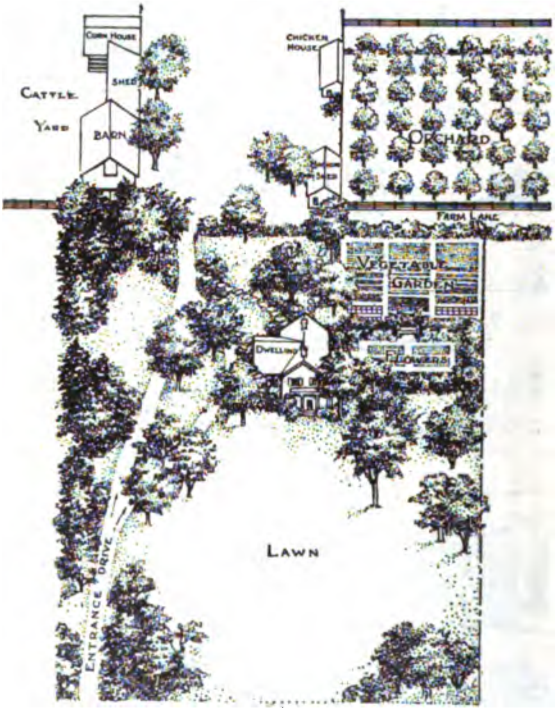

FIG. 9.—Plan of a farmstead located near the highway.

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[1] Topography is a general term applied to elevations, slopes, hollows, marshes, water courses, and other surface features of the land. A map showing such features is known as a topographical map.

orate and pretentious; whether the greatest possible economy of funds and lands is essential or whether a liberal expenditure is permissible. Further, a general conception must be formed of the style of place that is desired; whether free and open or secluded, whether austere and commanding or cosy and retiring, whether massive or airy, palatial or simple, somber or gay, pretentious or modest, forbidding or hospitable, dignified or riotous.

STYLE OF THE DESIGN.

So far no distinctive type of American farm architecture has developed, although some localities have evolved typical styles. Examples of these are found in New England with the house and barn connected by a woodshed (fig. 10); in central New York with a story and three-fourths house and a moderate-sized barn; in southeastern Pennsylvania with its bank barn of stone, stable high with an "overshoot" on the south (fig. 11) and a moderate-sized dwelling; and in the South with large houses (fig. 12) and the other farm buildings subordinated. Because so much of our farming country is flat it would seem that the ultimate prevailing style should be low and spreading and that the prevailing lines should be horizontal, to make them harmonize more nearly with the landscape. Small communities with special conditions will be likely to develop their own styles.

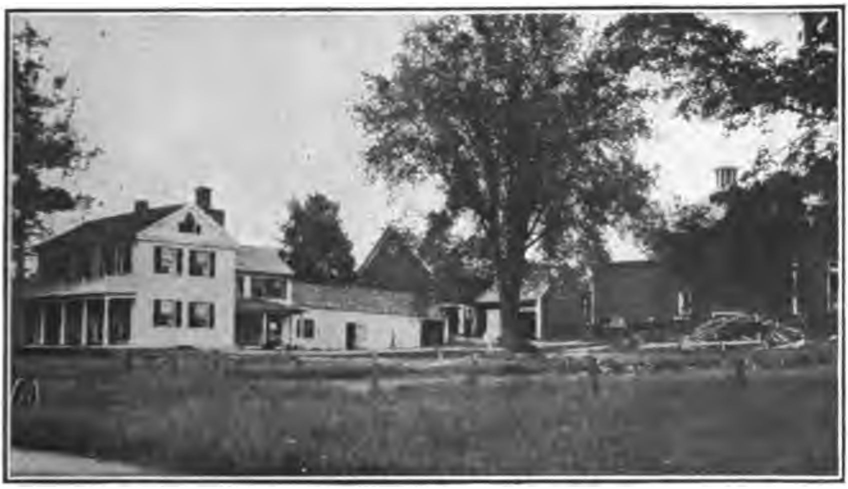

FIG. 10.—Typical New England farm buildings.

An important thing is to have the buildings on any farm sufficiently similar in appearance to seem to belong together (fig. 13). The barns should all be of the same general style, and the houses should be livable and attractive, but not so different in their general lines as to seem out of place (figs. 14 and 21).

After these factors are determined the type of landscape treatment must be studied so as successfully to apply that which is best adapted to farmsteads. In general, only informal designs are applicable except in limited garden areas, but in order to understand informal design better it is desirable to have a clear idea of formal design. Formal design in landscape (see the flower gardens shown in figs. 4 and 36 and the plan illustrated in fig. 15) is composed of geometrical figures, usually symmetrical,[1] and always balanced.[2] It is frequently emphasized by architectural or sculptural additions. In general, the more straight lines are used the greater is the formality. The buildings need to be regularly and symmetrically placed and appropriately designed. The ground must be graded to suit the plan. All the details both of grounds and of buildings must be carefully worked out to conform with one another, and the upkeep must be of the best continually. Formal design is inelastic, not readily permitting additions, and is relatively expensive both in installation and maintenance.

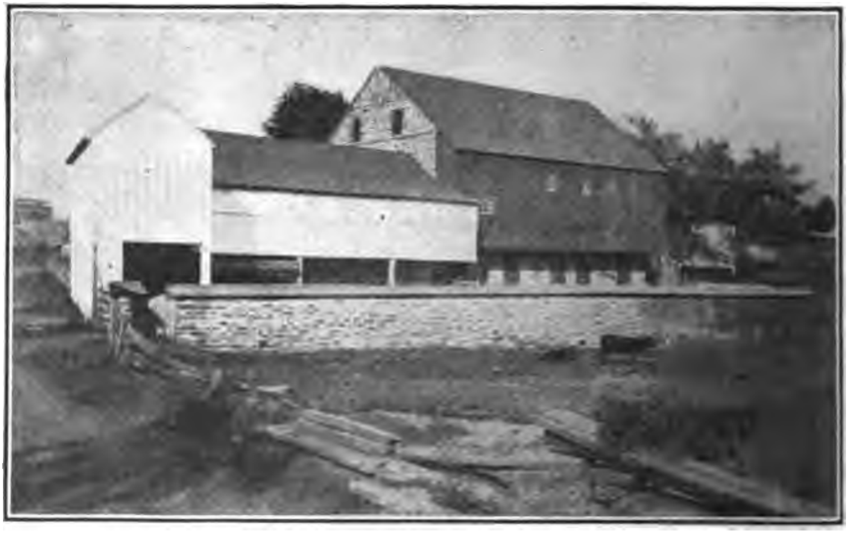

FIG. 11.—A typical barn of southeastern Pennsylvania.

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[1] "Symmetrical" in landscape design means that each part on one side of a central axis is exactly duplicated on the other. Each half of the design reflects the other half. This does not mean that the two sides must be alike in their details, as the design may be symmetrical only in general outline.

[2] "Balance" in landscape design means that the features on each side of an axis are of equal interest, but not necessarily alike. A symmetrical design is balanced, but a balanced design need not be symmetrical. The axis must be in the center of the interest, not necessarily in the center of the design. A large area of lawn with little planting on one side of a walk may be balanced, for example, by a smaller area on the other if it contains more striking objects.

Informal design in landscapes (see figs. 6, 9, 16, and 28) is composed of irregular, unsymmetrical, unbalanced figures. In its purest form it consists entirely of irregular curved lines. When straight lines or regular curves do appear in informal landscape designs they are united with architectural features, such as buildings, boundaries, steps, tennis courts, and formal gardens. Informal design is economical in development, as it usually can be made to conform closely to existing conditions, thus reducing grading to a minimum. It can be maintained with little work.

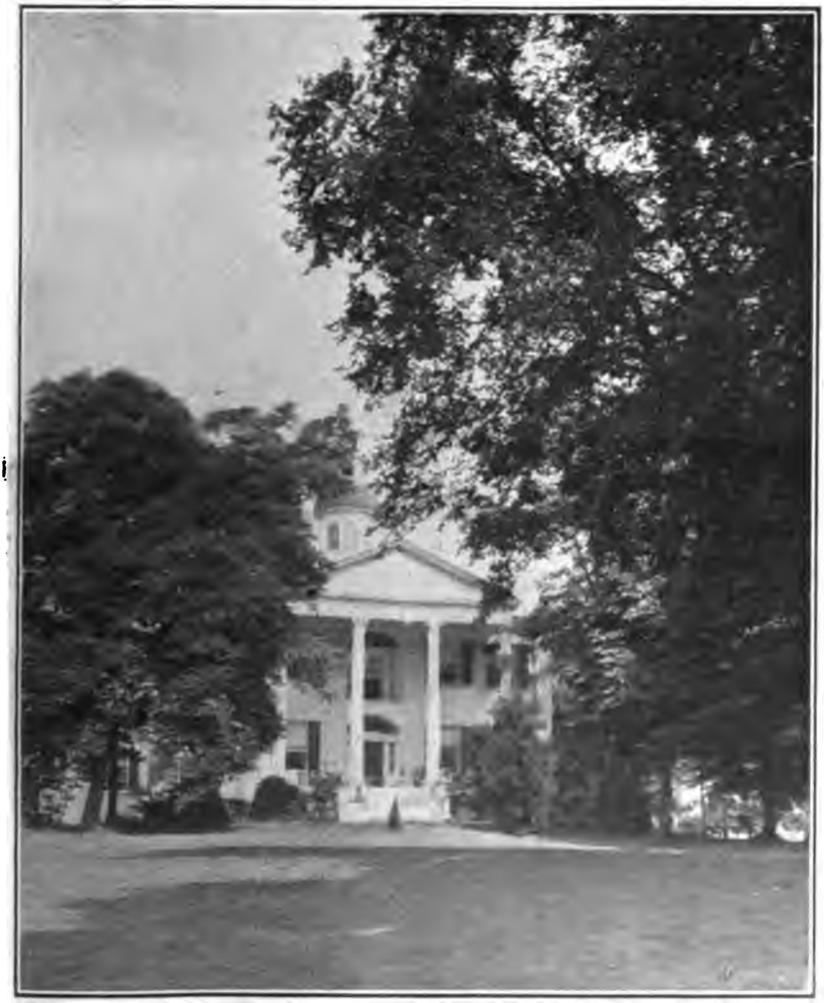

FIG. 12.—A typical mansion south of Mason and Dixon's line.

Each plan is a study in itself and only by considering the conditions to be met can a successful one be made (fig. 15). The making of a good plan of the informal style is not difficult if an effort is made to meet the existing conditions without attempting to do things simply for show.

In applying the suggestions made in the following pages it will be found frequently that more than one applies to the particular case but if that one is carried out the other can not be followed. The designer has to choose between such alternatives. The successful plan is one in which compromises are successfully made to give a livable, workable whole with an appearance of modest comfort.

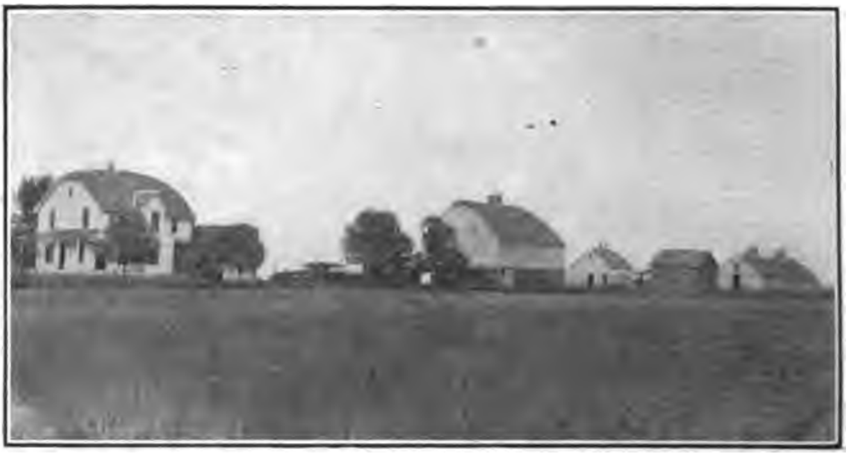

FIG. 13.—Buildings should appear to belong together.

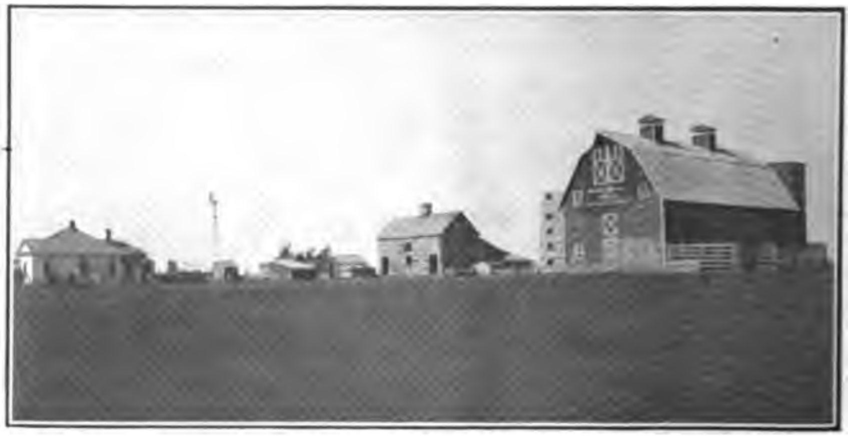

FIG. 14.—Farm buildings out of harmony.

Although the number of details requiring attention may seem confusing on the first reading, when the attempt is made to apply them they will be found to be comparatively simple. On most farms this work can well be planned and carried out by the farmer and his

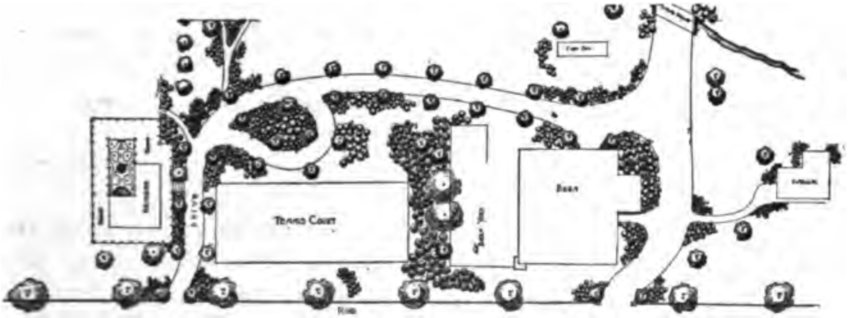

FIG. 15.—A plan for a farmstead when a good house, barn, and tenant house were already erected close to the public road.

family. It is necessary to decide, first, the working and living conditions that need to be met, and, second, the impression which it is desired that the home shall give. For the more expensive places and for smaller places where much grading is involved, the employment of a landscape designer is usually more satisfactory and economical. In most communities there are no well-trained men available to advise in such matters on terms within the reach of the small-home owner. In localities well organized for community work it may be possible to secure a landscape designer and an architect to help several in the community at one time. If the plan is good much can be accomplished in the way of improved appearance with only a little work required for installation and maintenance. If too much ground is included in the farmstead or the design is made too intricate, the care of it will

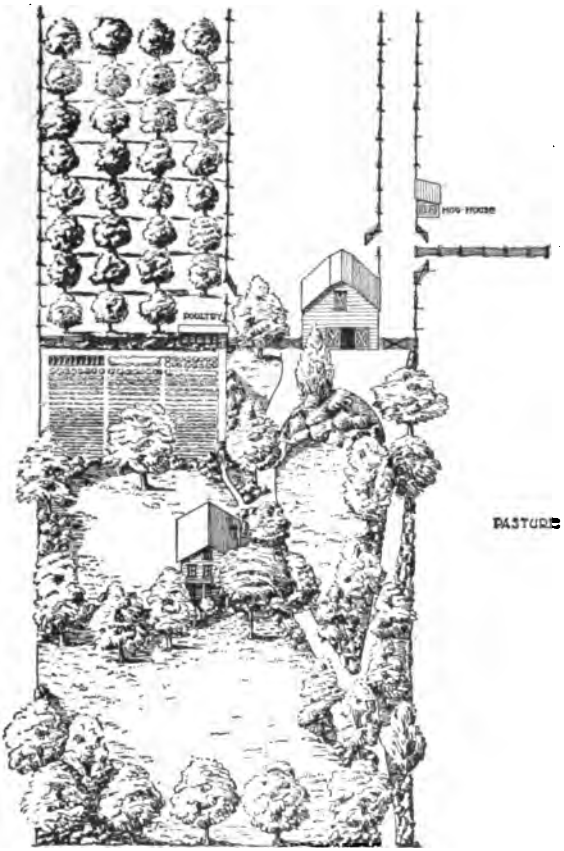

FIG. 16.—Plan of a 2-acre farmstead.

be burdensome. A little ground neatly kept is more attractive than more ground not well maintained. On a small farm 2 acres can often be made to accommodate the buildings, with fruit and vegetable gardens, adequate for a small family (fig. 16), while on larger places 10 acres or more may not be inappropriate.

If a formal flower garden (see figs. 4 and 36) or other features that require special attention in maintenance are desired, the grounds should be so planned that these features may be added after the other portions are developed and the amount of care which they will require has been determined from experience. In this way, features calling for special maintenance will be limited to the labor available. No rules can be laid down as to the character or extent of landscape development that can reasonably be maintained. One person will slip into the garden for five minutes two or three times a day as a relaxation from regular work and almost unconsciously pull a weed here, train a vine there, and so have a large part of the work done without realizing it, while another can not accomplish this without a special trip for the purpose. The personal tastes of the members of the family will determine very largely the extent and character of the development.

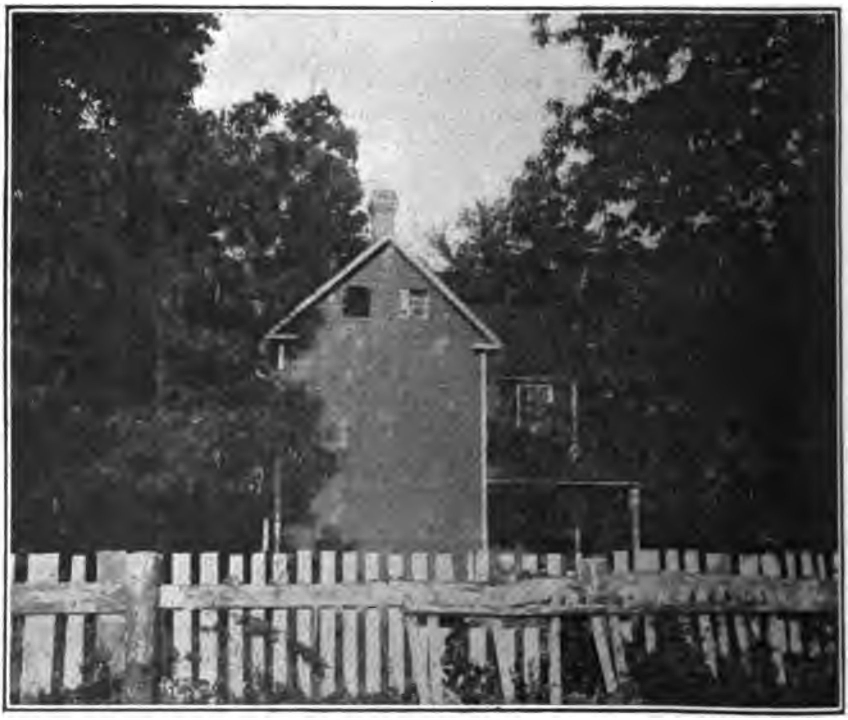

FIG. 17.—A familiar type of farm or tenant house in many parts of the country. Compare with figure 18.

LOCATION OF THE BUILDINGS.

The appropriate size of the grounds is dependent on the size and style of the house and of the farm and farmstead as a whole. The more pretentious the buildings, the more ground is required to give a proper setting. Cramped grounds dwarf the effect. Too much ground is undesirable because the care required is out of proportion to the needs.

The essentials of a good design for a home are that the buildings and grounds shall be comfortable, convenient, appropriate, and attractive. This holds whether the place be large or small, whether there is one small house on a small lot or whether there are several large buildings on a farm. The first three conditions should be solved with the fourth constantly in mind, so that all will be worked out together.

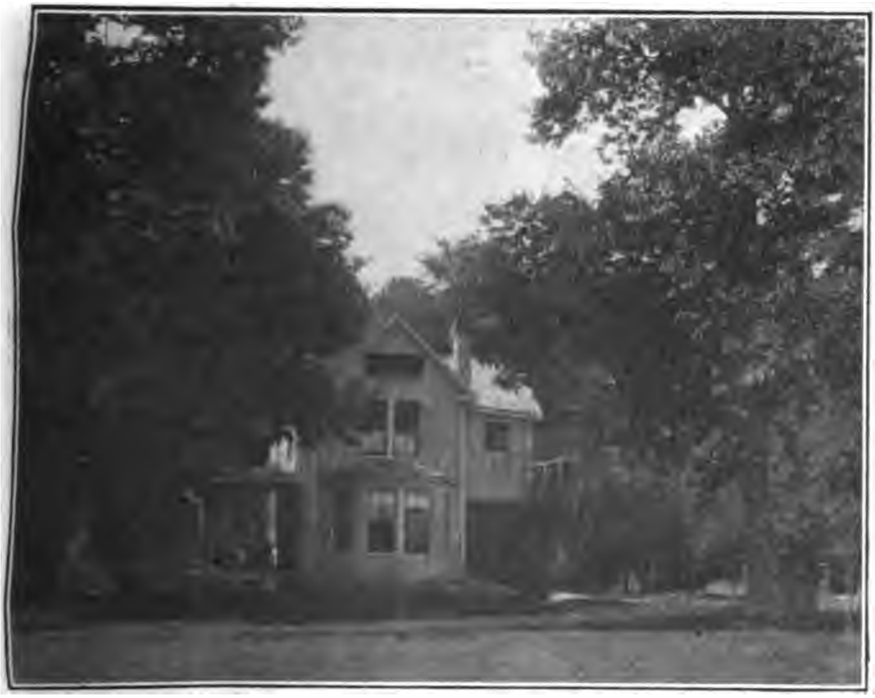

FIG. 18.—A transformation in the appearance of the house shown in figure 17, made by attention to details.

Sometimes a slight change will work wonders. Every one is familiar with the type of house shown in figure 17, but few realize how the changing of the location of a chimney and the addition of windows and porch will improve its appearance, as shown in figure 18. Of course, the removal of the fence adds to the attractiveness of the place, but by covering the lower portions of both pictures it will be seen that the fence is only a minor factor. The exposure is one of the most important considerations for securing the comfort of the family. In cold countries protection from the winter winds is desirable and the location of the most used rooms should be on the warmest side of the house, while in warm countries the house and living rooms need to be so located as to get the benefit of the prevailing winds during the hottest months.

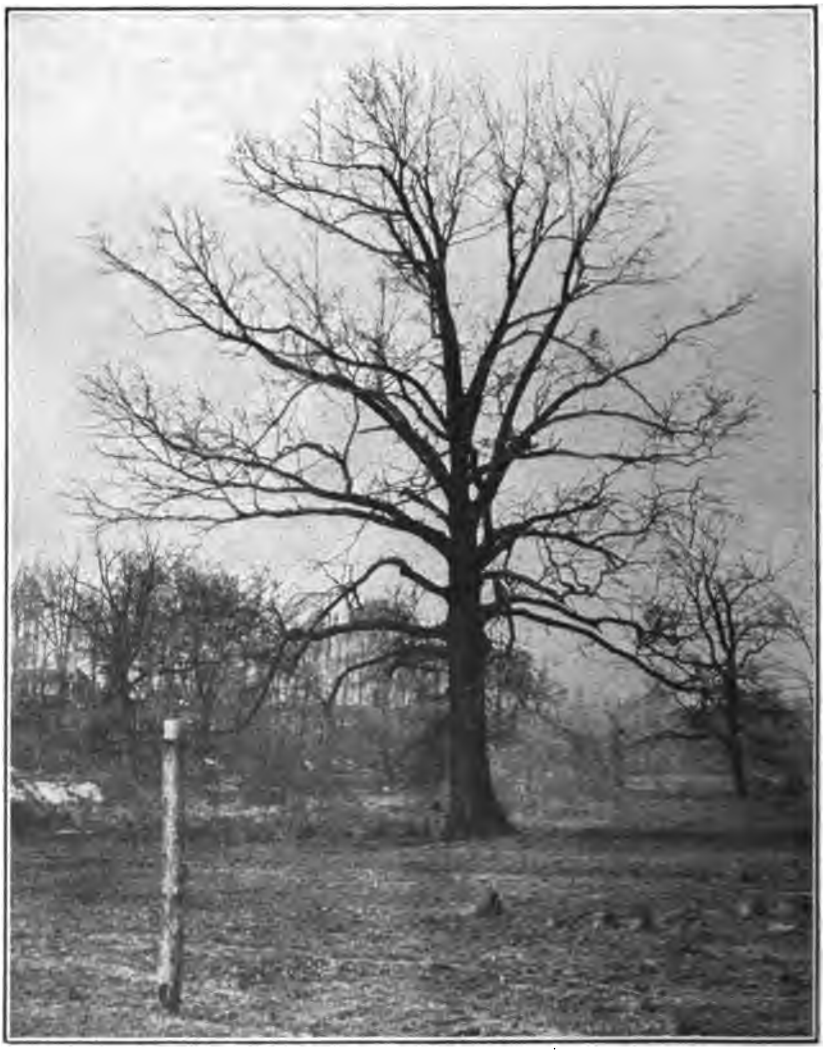

FIG. 19.—A view from a living-room window.

The elevation should be such as to make possible thorough drainage, even though it may be desirable to keep off the highest ground.

Under no circumstances should the house get the drainage from other buildings.

If at all possible, the house should be so located near good trees that their shade may be used and enjoyed by the family every day during the summer. It takes so long to grow good trees that existing trees should be cherished and utilized to the fullest extent.

The outlook, too, should be well considered and the rooms used most should be given the benefit of the best views; those from the kitchen as well as from the living room should be attractive. The near view should be over an unbroken lawn, and there should be some object of interest beyond. If there are no such objects in the general landscape, such as a mountain, a water view, a woodland, a meadow, or an extended farm view, a handsome tree (fig. 19) or other bit of near-by landscape may be available. Lacking these, possibly some feature may be created on the place, such as an attractive group of shrubs, well placed and arranged so as to have something of interest each month. Good views should be sought or created and utilized to the greatest advantage.

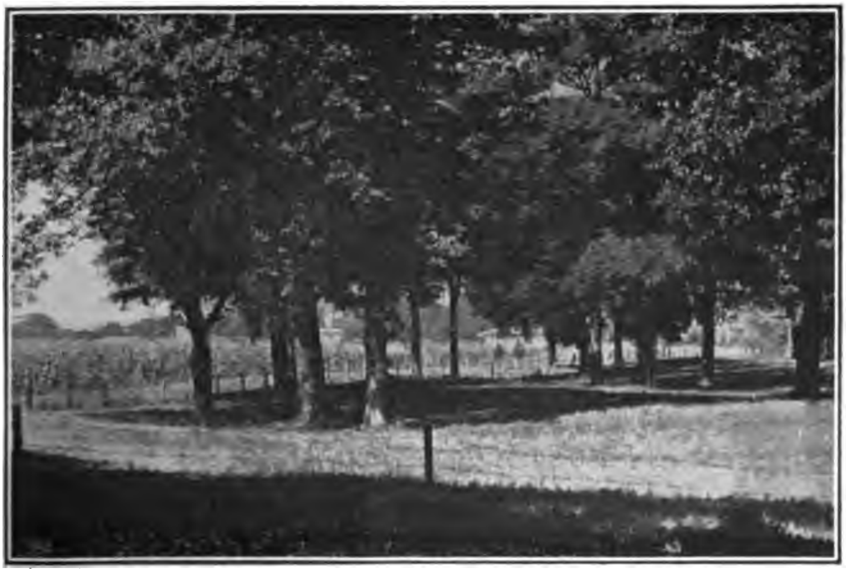

FIG. 20.—A pasture as an extension of a lawn.

In a hilly or mountainous country a site should be selected that will provide a little level land immediately adjoining the house. This is necessary both for appearance and for comfort in living. Where such a setting is not provided the house is likely to give the impression of being about to slide from its location, while with a little level ground close by it may give the appearance of fitting closely into the site. In the case of a side hill or bank house it may be necessary to build with one side facing on a higher level than the other. If the level areas are of reasonable extent, although at different heights and separated from each other, the desired impression may still be given. The many discomforts of living with a side hill at the threshold are a vivid reality only to those who have experienced them.

The area that should be set aside for the house lot is dependent on so many factors that it is hard to give rules. The larger and more pretentious the house the more land should appear to be with it. The least there should be is the greatest amount of space that the family can use and enjoy. The minimum would seem to be five times as much ground as is covered by the house, although twenty times as much would be better, with enough room added for a tennis court, croquet ground, or other playground, and a liberal flower garden. Though it may be necessary to have a lawn which is small, it is frequently possible to increase the apparent size by making adjacent areas appear to belong with it (fig. 20). If the apparent size can not be increased, as suggested under lawns, it should be at least possible to prevent the dwarfing of the appearance by growing only low crops in the near-by fields, keeping tall crops and orchards at a little distance. Where this is impracticable the area of the home lot should be doubled or trebled.

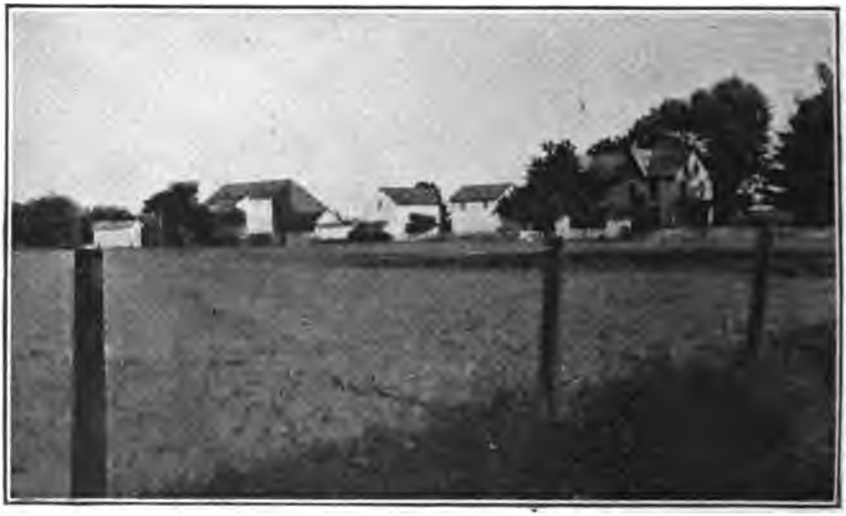

FIG. 21.—A farmstead having too many unrelated buildings.

The barns as well as the house should be well located, and not only must they be properly arranged to facilitate the farm work and be accessible to the road, but they must be reasonably convenient to the house without being too close, prominent, or obtrusive. They should be so situated with respect to the house that the prevailing winds, especially during those seasons when the doors and windows are likely to be open, do not blow from the barns toward the house. On the other hand, in cold climates the barn as well as the house needs protection from severe winter winds.

Further, the buildings must be arranged for convenience. The interior of the house and its connection with the outside features, whether with the barns or the public road, should be adapted to the everyday life of the family. All too common examples of inappropriate farm architecture are front doors that are never used except for funerals and parlors that are so seldom used that when they are used they cast a reserve over the whole family. Drives and walks to such front doors are a meaningless formality and should be eliminated. In a house of such design the neighbors usually go directly to the kitchen, because they know that is the entrance the family uses, and the life of the family is so far from the front door it is impossible to get any response even if the attempt is made. A more pleasing and satisfactory arrangement is to have the entrance open directly on the part of the house the family uses, as shown in figures 6 and 9.

The entrance should be so located as to be easy and natural for both the family and visitors to use. The approaches to it should be so direct that there is no feeling of being taken out of the way in following the roads or walks provided. In such an arrangement the entrance and approaches are naturally used in accordance with their design.

The barns should be at a little distance from the house, but close enough to facilitate the work to be done, and of such a character architecturally that they look as though they belonged together. The buildings should be as few in number as is practicable, or at least should have the appearance of being a unified group from the principal viewpoints. Such results can be brought about by careful grouping, sometimes even building them around a courtyard, or if necessary connecting some of them by sheds or walls. The objection to close grouping is the danger from fire, but facility in doing the work may be an offset to this. A number of small unrelated buildings gives a " cluttered up " appearance, as shown in figure 21.

WALKS AND DRIVES.

The entrance to the farmstead from the public road is one of the most important details of the plan and one of the most difficult to treat successfully without underemphasizing it or overdoing it. It should be so located as to facilitate direct and easy access to both house and barn and make the approach to either seem natural and easy, while at the same time appearing to lead primarily to the house. On the other hand, it should not be directly opposite the front door of the house, so that on entering one appears to be going straight into the house, except possibly in extremely formal developments. In informal developments an entrance to th[illegible]stead on the axis of the front door is not pleasing, even tho[illegible] the approach road swings well to one side after leaving the entrance. (Figs. 22 and 23.)

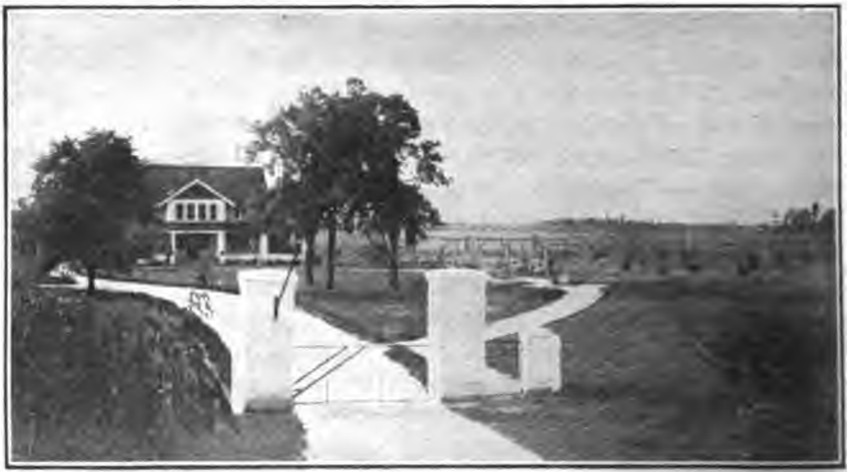

FIG. 22.—An entrance that gives a bad impression. Compare with figure 23.

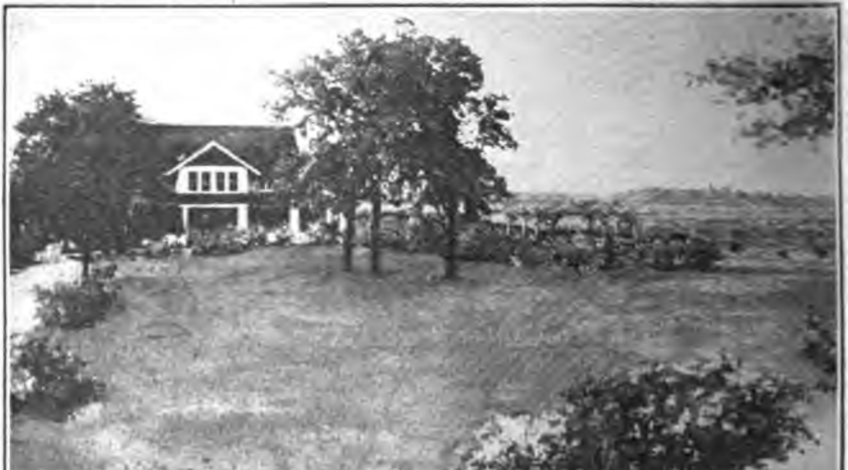

FIG. 23.—The farmstead shown in figure 22 improved by placing the entrance to one side.

The entrance should largely reflect and suggest the character of the farmstead. If the farmstead is formal, the entrance should be formal, but if the farmstead is informal, the entrance should be simple. The less formality there is in the farmstead the less there should be at the entrance. On the other hand, some special treatment is necessary to attract attention to it and set it apart from the rest of the boundary and to invite entrance, at least to the extent of inciting the wish to enter in those passing.

. The character of this special treatment must so nearly correspond with the rest of the treatment of the farmstead that it can be united with it without an abrupt change of style at any point. The transition from a heavy stone or brick post to a barbed-wire fence is difficult unless the size of the farmstead is such that there is sufficient distance to make the transition gradually. If the post is flanked by a wall of the same material that ultimately becomes the same height as the fence and the fence and wall are covered with vines for a considerable distance on each side of the joining, a successful transition can be accomplished. Such a stone wall, however, is inappropriate unless built of native stone in evidence in fences or buildings in the neighborhood or else is like the stone or brick clearly evident in the foundation or other portion of the buildings.

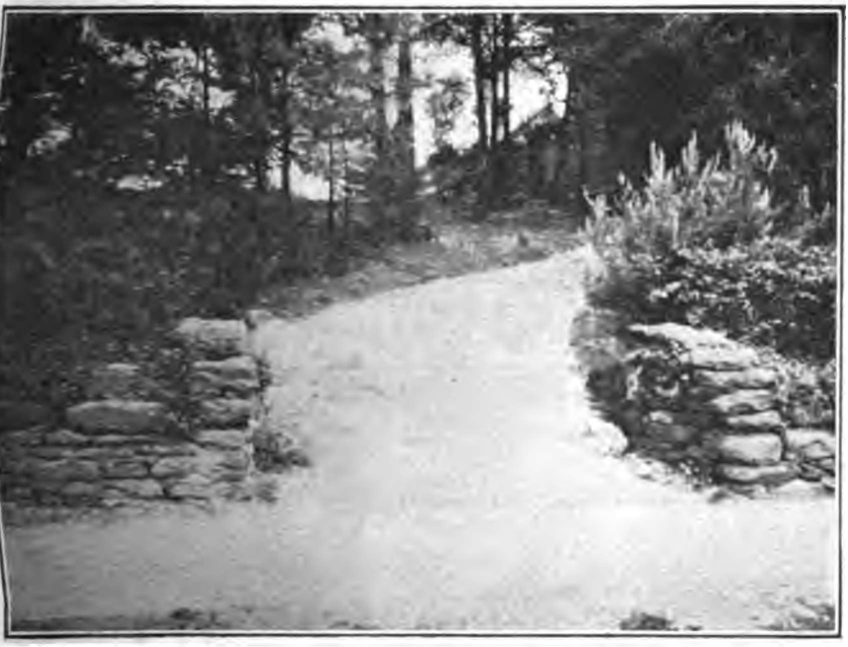

FIG. 24.—A well-designed entrance. The appearance of the stone wall has been improved by recessing the cement joints.

The design of the wall also has an important bearing on its appropriateness. The wall of native stone in figure 24 is appropriate and attractive. Figure 25 also shows a good entrance for its location, but one which would be most inappropriate were it not for the heavy background of trees. The wall is good and is well covered with

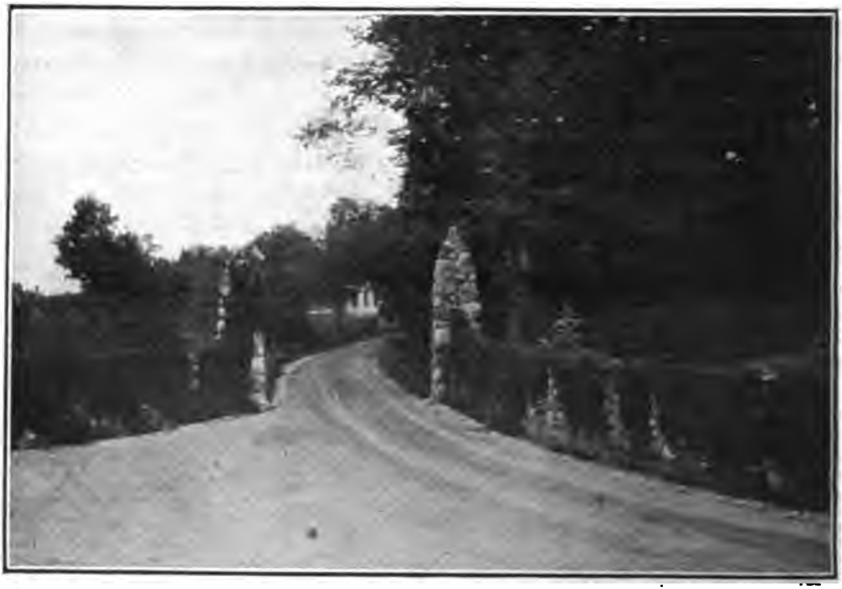

FIG. 25.—A good gateway and wall for the location. Were it not for the mass of foliage behind, the posts would be too tall and too heavy.

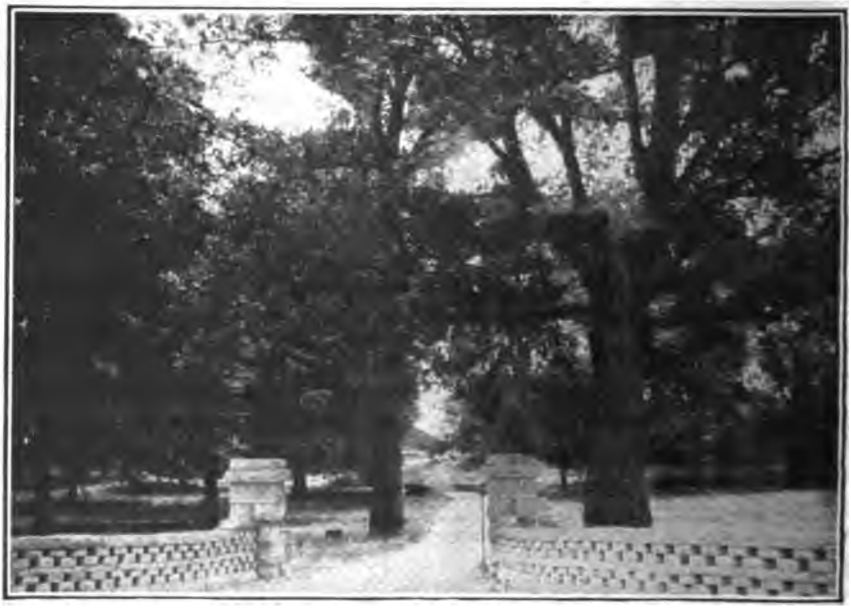

FIG. 26.—A wall suited only to a formal landscape.

vines. The posts would be too heavy as well as too tall in most situations. The wall in figure 26 is so formal in design that if used at all it should be only with a formal landscape, and then only when the buildings are of a similar checkered design.

Plants can be much more easily arranged to emphasize an entrance without overdoing it than can architectural features. Entrance plantings may either be formal, such as hedges or regularly placed specimens or clumps, or they may be altogether informal and irregular, as shown in figure 27.

As with all other details of the farmstead, development at the entrance, whether primarily of plants or of other material, must be appropriate in size, shape, and kind. Especially with plants there is a wide latitude of possibilities that may be appropriate, but the limits must not be exceeded if a fitting result is to be obtained.

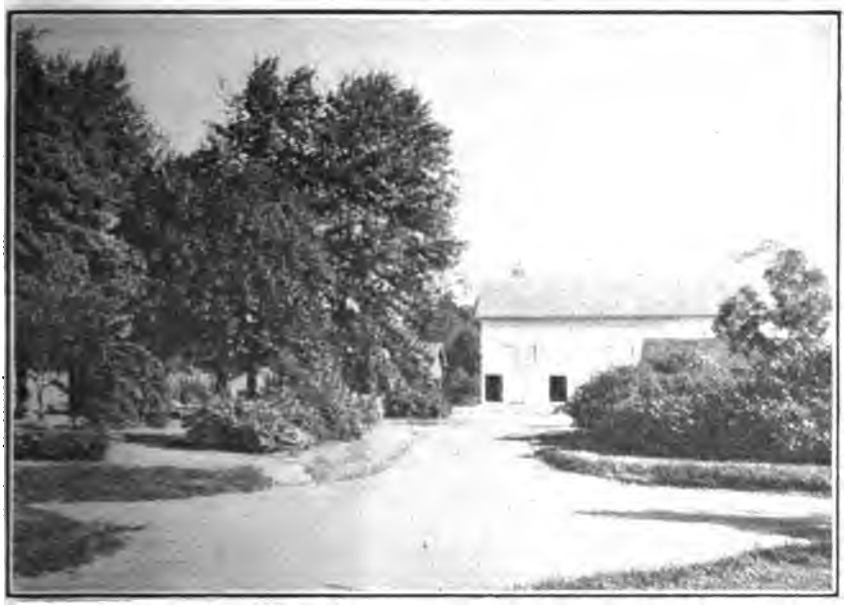

Fig. 27.—Informal plantings at the entrance to a farmstead.

The approach to the farmstead should be direct, but as a rule not straight toward any of the buildings. Where the buildings are near the highway a good plan is to have a single road enter the grounds, then to divide, one branch going directly to the barn and the other past the side of the house, passing near the main-entrance door, thence near the kitchen entrance, rejoining the road to the barn in such a way that the traffic may conveniently pass to the barn or return to the highway. (See figs. 6, 16, and 28.) This arrangement of a double road is to permit traffic to reach the barn without passing close to the house, while not greatly increasing the extent of road surface. The approaches should be so curved as to permit plantings to hide partially the barns and service yards and thus screen them so that they will not be too conspicuous to those approaching. In hilly countries the topography or lay of the land will largely determine what may be done in the matter of approaches, and it correspondingly gives opportunities for variety of treatment.

In flat countries the problem of providing a convenient approach is not so difficult, but, on the other hand, it requires considerable thought and care to have it convenient without being commonplace and uninteresting.

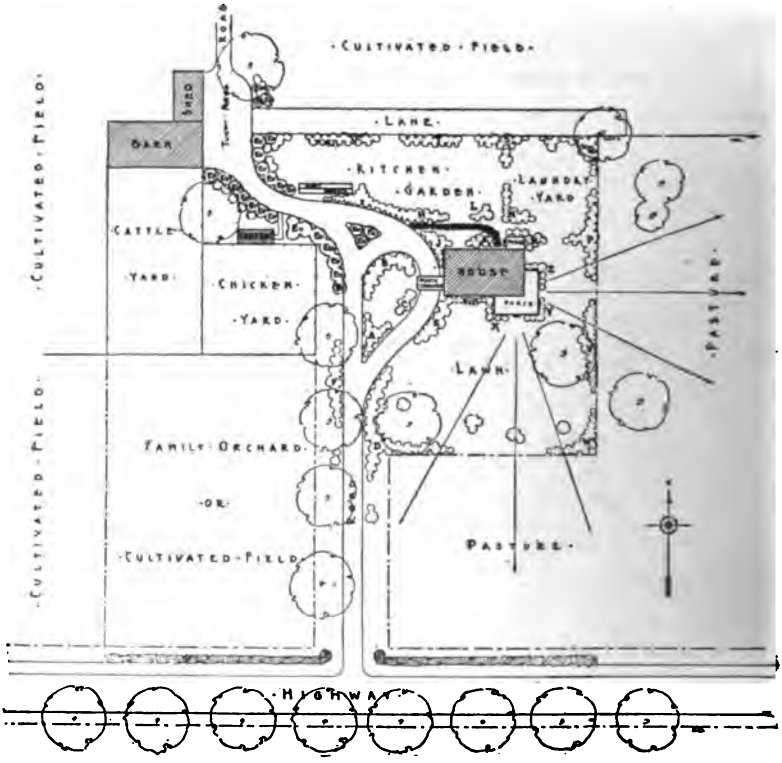

FIG. 28.—A good approach to a farmstead.

Where the buildings are located some distance back from the highway an approach from the public road to the group of buildings becomes necessary. In hilly countries this approach will often need to be curved or crooked in order to avoid objectionable grades. As far as possible the road surface should be kept hidden from the home, but on approaching, the visitor should from time to time get glimpses of the house and should feel that he is going toward it, although not straight at it. In a flat country, especially where the farms are all laid out in rectangles, the approach road from the highway had better be straight till it reaches the farmstead (fig. 29), when the same general scheme may be adopted as though the farmstead were located directly on the highway. Such an approach road will be likely to run parallel to the lines of the house and barns, but it should not run directly toward either. A public building may be appropriate as the terminus of a vista made by a straight approach road, but a farmhouse or barn seldom is. A long straight approach road is made more effective by a row of trees on each side, forming a vista under their tops. There should be some attractive object to which the eye is drawn at the end of the vista, or at the "focal point," as it is called. This object may be an attractive landscape, a beautiful tree, or a clump of shrubbery. It is seldom desirable to have an entrance door at the focal point of a combined business and home drive, such as the approach to a farmstead. Where a door is used as the focal point of a formal drive it should be merely an entrance door, not the door that leads to the lawns and pleasure grounds of the family, as the latter should have more privacy than could be given a door fully exposed to view from the main approach. On the other hand, ugly or uninteresting objects should not be the terminus of such a vista. (Fig. 30.) Trees or a clump of shrubbery, especially if composed mostly of evergreens, can help such a situation greatly. The other walks and roads about the farmstead should be as few as possible. All real needs should be met, but no provision should be made for fancied or possible ones. If in doubt leave out a walk until experience shows the need of it. The place where

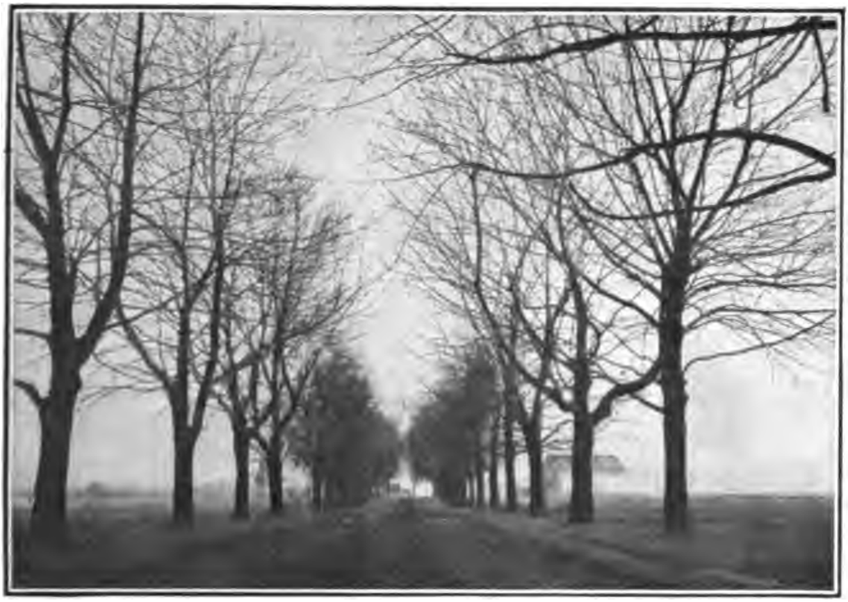

FIG. 29.—A good entrance to buildings located well back from the highway.

it is supposed it might be needed can be put in turf until its need is demonstrated.

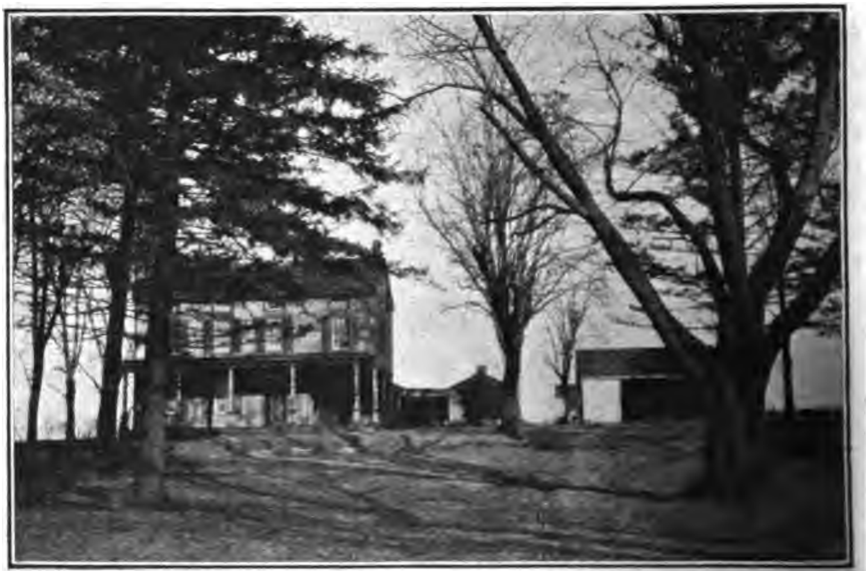

FIG. 30.—An inappropriate approach to a farmhouse. The opening to the woodshed could easily be screened by a careful planting of evergreens.

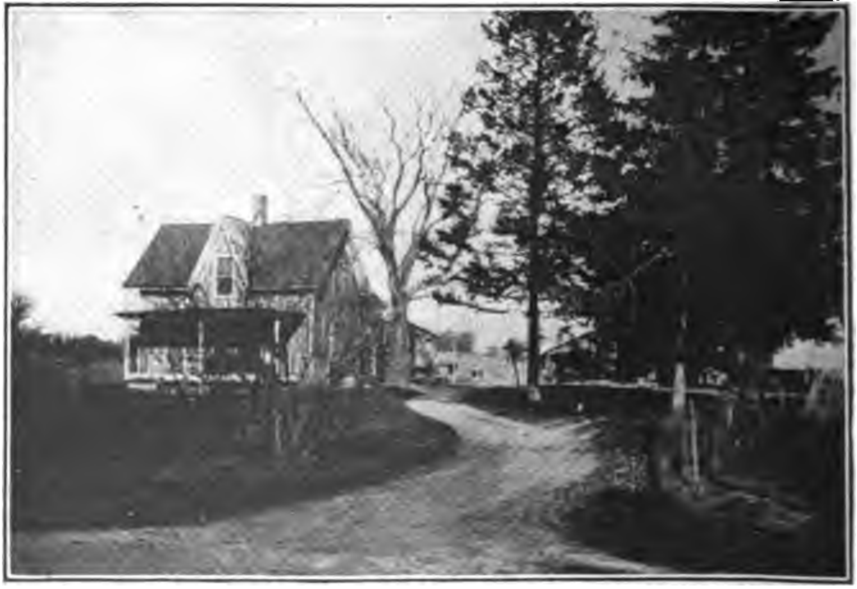

FIG. 31.—A good approach for buildings near the highway.

All roads and walks should be so located as to give the feeling of leading to their destination without unnecessary turns. This does not mean that they must be straight. They may be slightly curved and yet give the impression of leading to the desired end. In informal designs, where the distance is not too short, a curved walk or drive (fig. 31) gives a more pleasing effect than a straight one. The amount of curve need not be great, often a deviation of the width of a walk or drive (fig. 32) will answer, while 1½ times its width will be ample. On the other hand, curves should not be too abrupt, and there should appear to be a reason for each. Appropriate plantings can often be made to supply this reason if no other can be provided, and they are always useful in supplementing other reasons. In a rolling or hilly country the slope of the land can usually be made to give an excuse for the curves.

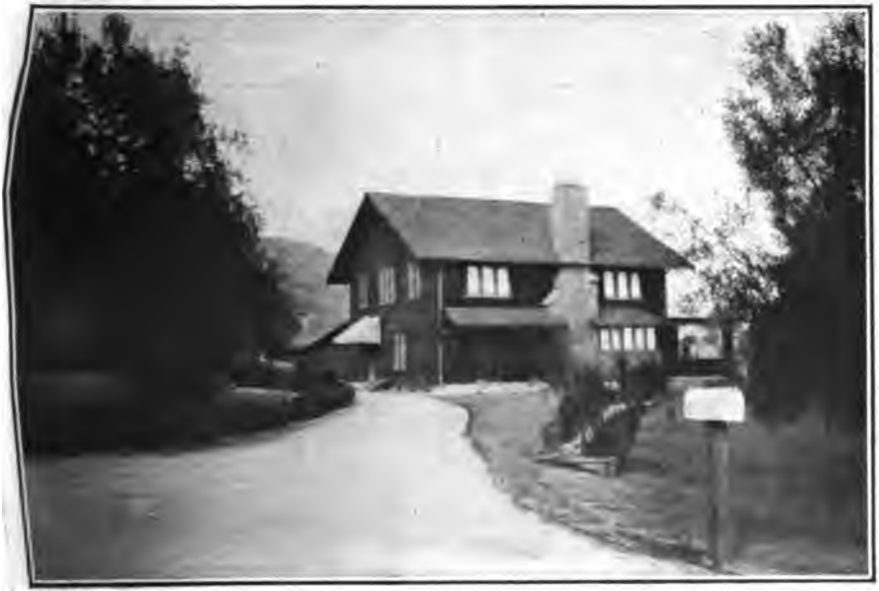

FIG. 32.—A satisfying result with a slightly curved roadway, a deviation of not more than its own width.

Paths and roads should not only be as few as possible, but should be kept out of sight as far as is feasible. Where practicable to conceal them, at least partially, by construction behind knolls or through depressions, it should be done if it does not interfere too seriously with their directness and if good drainage can be provided. Often artificial knolls and depressions are constructed to hide them, but this is seldom warranted unless the farmstead is large and the fund for development is liberal. On the other hand, a study of conditions and a little work may often accomplish wonders. Finally, plantings of trees or shrubbery may be used (fig. 33) after everything practicable has been done in other ways. Paths should not be installed where established roads can be utilized, even though it may take extra care and expense to keep the road surface in condition for the dual purpose of a walk and drive. If it should not be practicable to keep the road in good condition for foot traffic, of course a separate footway would need to be developed, but it should be omitted unless really necessary. Both from the standpoint of appearance and of expense of upkeep the fewest possible drives and walks should be provided. A little-used walk or drive is usually as troublesome and as expensive to keep up as a much-used one, as it will grow full of weeds and will wash whether used or not.

The surfacing will depend on local conditions. As a rule, farm roads will be made of the natural soil and should be well crowned and provided with good gutters with liberal outlets. In most parts of the United States little-used roads and many paths, even though much used, can be covered with turf and mowed, like the lawn. If the road is used sufficiently to cause ruts, soil can be brought to fill them. Where a more resistant surface is needed for a short time each season, stones 2 inches in size or larger may be mixed with good soil and the road formed of that material. Grass will grow in the soil and the stones will not permit a cutting up of the roadbed or the permanent destruction of the grass. The grass tops may be worn off by the traffic, but the roots will push out again after the wear ceases. Turf gutters (fig. 34) may be found satisfactory for road and walk drainage in all sections where there is sufficient moisture to maintain turf growth. To be successful, no ridge or shoulder should be permitted between the turf and the

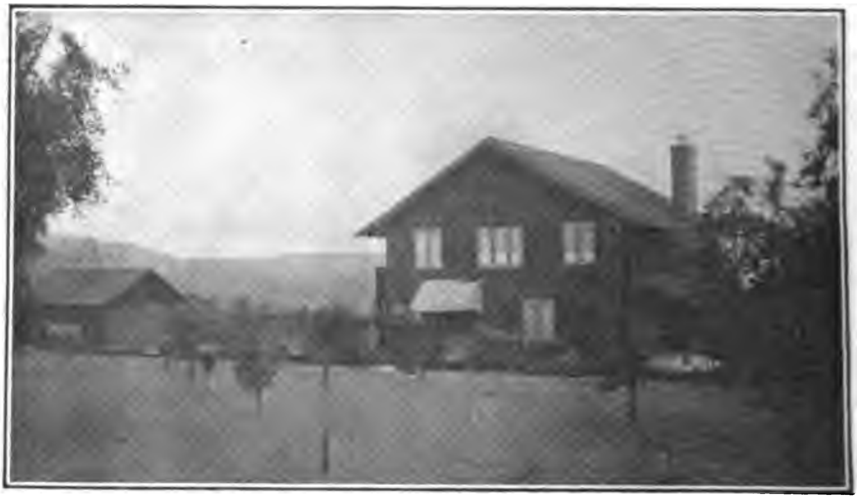

FIG. 33.—A well-hidden approach and service road. See figure 32 for another view of the same road.

road. Some material always collects in the gutter, gradually raising it, so that every few years it is desirable to lift the sod, remove some of the dirt under it, and relay it. Although this may seem like a good deal of a job, it will probably have to be done so infrequently as to prove one of the most economical ways of maintaining a gutter. Where an artificial road surface is needed, it should be as inconspicuous in color as possible. Cinders are one of the most desirable private-road surfacings, both on account of the color and because of good road-making qualities. Oyster shells, crushed limestone, concrete, and light-colored brick each have an objectionable color, contrasting too strongly with the normal green of country surroundings. Limestone combined with some of the dark-colored asphaltic oils or concrete colored by lampblack is pleasing in appearance.

Turf makes a good surfacing for footways that are only in use under favorable weather conditions, but those that are used in wet weather, especially if much used when frost is coming out of the ground, need some other material. Where available, nothing is more attractive than flat stones placed in the turf with the grass growing between, as shown in figure 35, but they need to be set low enough to permit the lawn mower to pass over them. If a cement walk is necessary, a dark color should be given it by the free use of lampblack, while crushed-stone walks can be held together and more suitably colored by using some asphalt or coal-tar preparation.

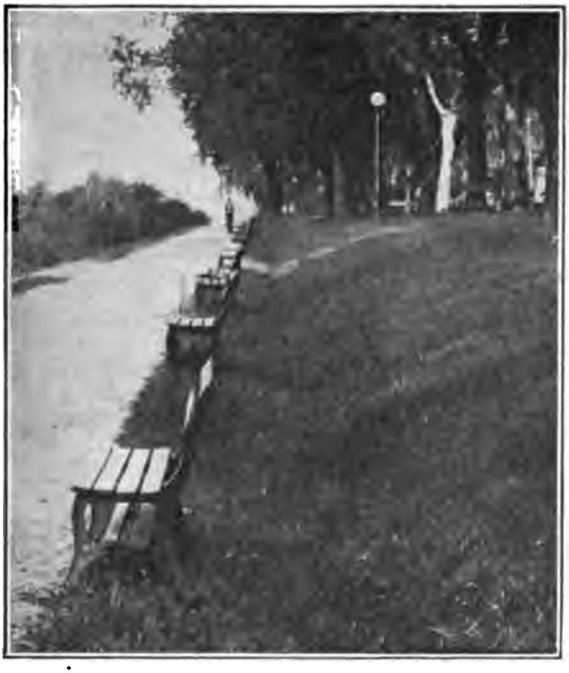
FIG. 34.—A turf gutter.

SERVICE FEATURES.

Provision must be made for features that facilitate the work of the farm or increase the comfort of living. These include such things as work yards, storage yards, and cattle yards about the barns, an ice house, a place for the storage of fuel, and a laundry yard near the house. Fruit, vegetable, and flower gardens must also be provided. Such features are all necessary, but should be so arranged as to serve the needs without being unduly conspicuous. One feature frequently overlooked is the provision for the delivery of the fuel supply near the place where it is to be used from roads arranged for other purposes. Failure to provide this is a continual cause of vexation. An ice house should be convenient in order to supply the daily needs of the family and yet not too conspicuous or too inaccessible for filling.

Wherever possible, buildings for several purposes should be united or be so located as to appear as one rather than multiply the number of buildings, as a large number of small apparently unrelated buildings detracts greatly from the appearance.

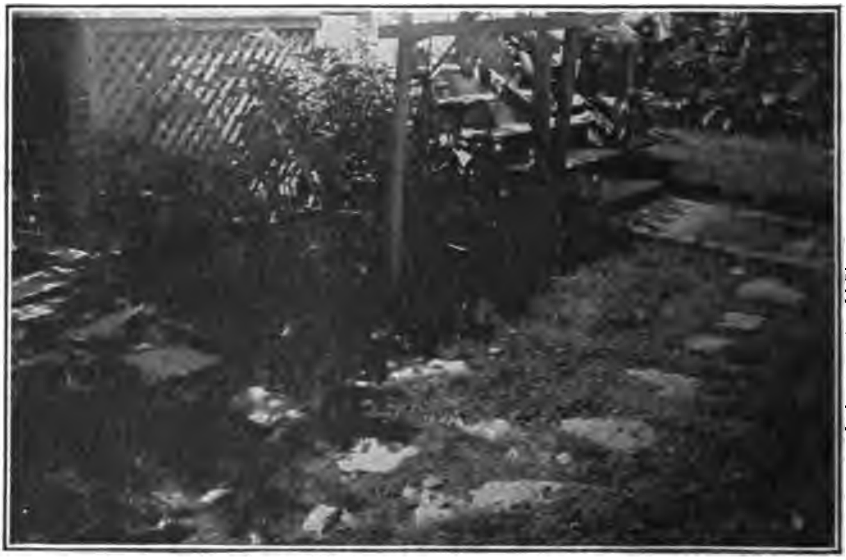

FIG. 35.—A stepping-stone walk.

The fruit and vegetable gardens and the garden for growing cut flowers for indoor decorations, as well as the ornamental flower garden, are part of the farmstead and should be used in its setting. They will be pleasing in appearance if properly placed, well laid out, well cultivated, and kept neat.

An orchard can add wonderfully to the setting of the farm buildings. A mature apple orchard kept in turf makes a delightful extension for a lawn. A well-arranged and well cared for fruit or vegetable garden is always attractive and may often take the place of a flower graden as a decorative feature and source of interest on the farmstead.

The placing of such gardens for the greatest effect may prevent cultivating them by horsepower. This usually should be avoided, because it increases the labor in upkeep. If it is impossible to adapt the gardens to the location so that they can be efficiently cultivated, it is best to move them to a place where it can be done. Two essentials of an attractive farmstead are neatness and the evidence of cultural success. The accomplishment of these should be made as easy as practicable without unduly sacrificing the decorative possibilities. It should be kept in mind that the more ornamental the garden is designed to be, the greater the care required in its culture and maintenance. The careful placing and arranging of fruit and vegetable gardens, however, should not be made an excuse for omitting a flower garden, even though it has to be a small one. Occasionally it may be combined with the vegetable or the fruit garden.

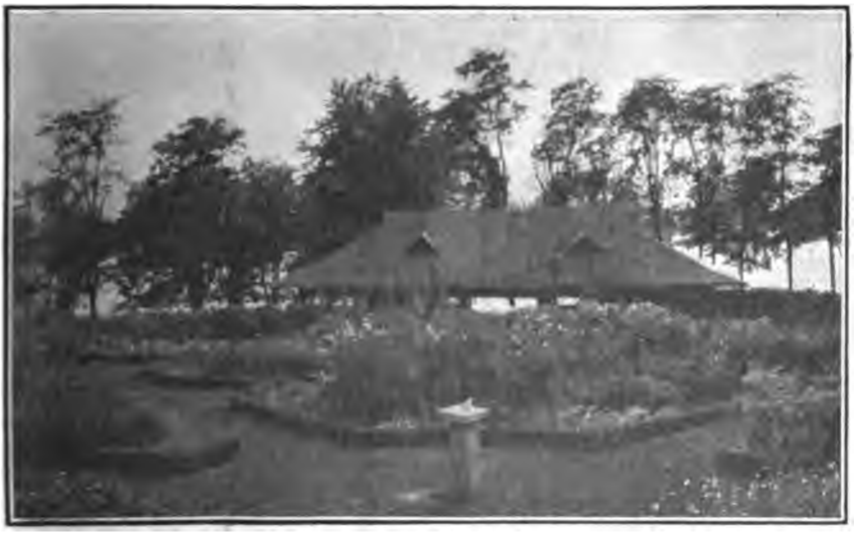

FIG. 36.—A formal flower garden with informal plantings.

An ornamental garden, whether devoted to flowers (see fig. 4), vegetables, or fruits, is in the nature of a transition from the formalities of the house to the informalities of the lawns. Its purpose and use should be largely that of an outdoor room. For this reason it should be near the house and somewhat secluded, having the privacy of a living room. In locating such a garden it should be kept in mind that views of the farmstead from the principal points should be largely open and free from special features that would distract the attention from the house. On this account, ornamental gardens should seldom be placed between the highway and the house, as the principal views are usually obtained from points on the public road. If they are so placed they should be made as inconspicuous as possible either by screen plantings or in some other manner.

An ornamental garden may be either formal (fig. 36) or informal, but in either case it should be regarded as part of the house and its activities, not as its principal setting. It comes closer into the family life if it is on the side of the house away from the public entrance and is near to the living porch, so that it is easily entered from the porch. It should be included whenever the family tastes and circumstances permit the expenditure of the extra labor involved.

Such a garden may be simple, involving little work, or it may be elaborate. It should be the most definite expression of the family tastes. A place for such a garden should be provided on the plan, but it may be left in lawn until the time comes for its development.

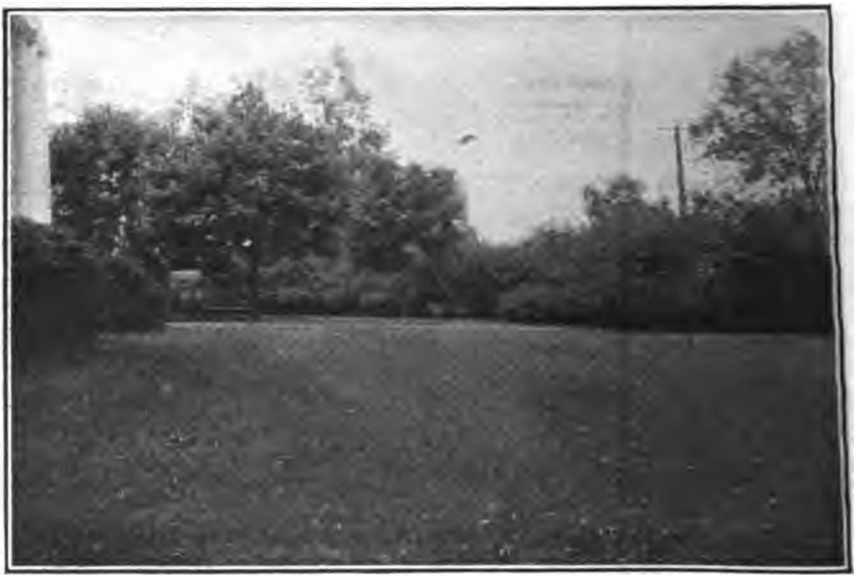

FIG. 37.—A lawn with irregular outlines.

Probably the greatest enjoyment of such a garden comes in its gradual making. The first step can be the planting of shrubbery borders to inclose it, followed the next year by the cutting of a few beds near the borders or at carefully selected points in the turf of the garden floor. By such steps it can progress until an intricate garden is completed, with its numerous beds and turf or gravel walks, or the garden may be left with a turf panel and narrow beds partially or entirely inclosed by shrubbery borders. Walks, arbors, seats, a summer house, or a pool may be incorporated if fancy dictates. Here personal taste may find free expression with less restraint from surrounding conditions than in any other part of the grounds.

Flowers about the house are to beautify the grounds; therefore to depend on such flowers for cutting is to defeat the purpose for which they are intended. Although flowers may at times be cut from general plantings or from an ornamental flower garden without injury or detriment, yet such plantings should not be regarded as the legitimate source of cut flowers, nor should cutting be permitted to such an extent as to mar the appearance of the plantings as a whole. Most of the flowers for cutting for indoor decoration should be grown especially for that purpose, either in rows in the vegetable garden, where they can be cultivated by horse tools, or in their own garden, which should be arranged for economical cultivation.

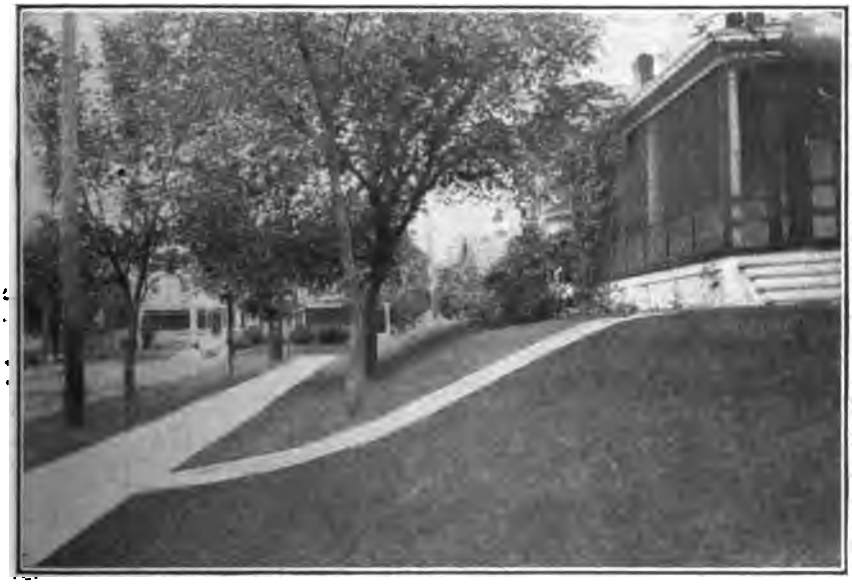

FIG. 38.—A sharp ogee. There should be no line between the convex curve at the top and the concave one at the bottom; they should merge one into the other.

LAWNS.

Lawns are most important for beautifying the farmstead. They are the background or foundation against which all the details are viewed. They should be in as large and unbroken stretches as possible, as this produces a pleasing effect, tending to give an impression of great extent and also making them easier to maintain. The borders should be irregular, as shown in figure 37, for an irregular outline increases the apparent size of the grounds by not revealing at one glance their actual limits. When bays on the lawn are formed by appropriate plantings it adds interest, as the depth of all the bays are not visible from any one point and, at once, curiosity is aroused as to what may be in the hidden places; thus the grounds are made more interesting and give an impression of greater size.

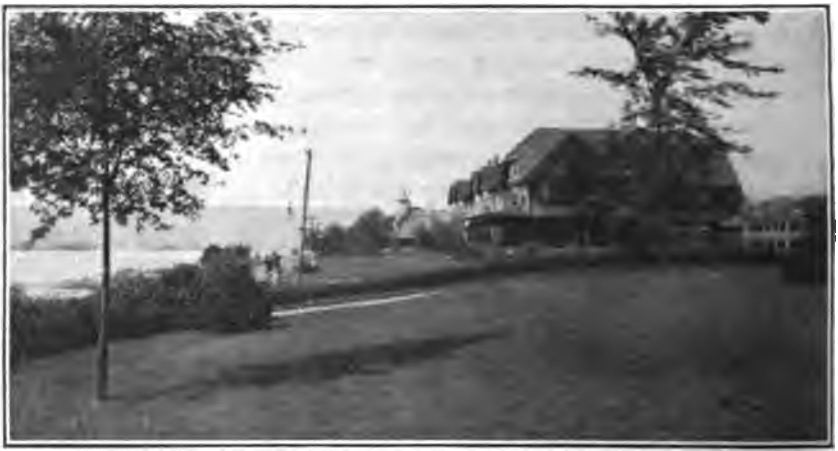

FIG. 39.—A long ogee.

The surface of the lawn should be smooth enough to pe[illegible]he easy running of the lawn mower, but many of the natural und[illegible]ns should be kept, and if the surface is inclined to be flat som[illegible]ort

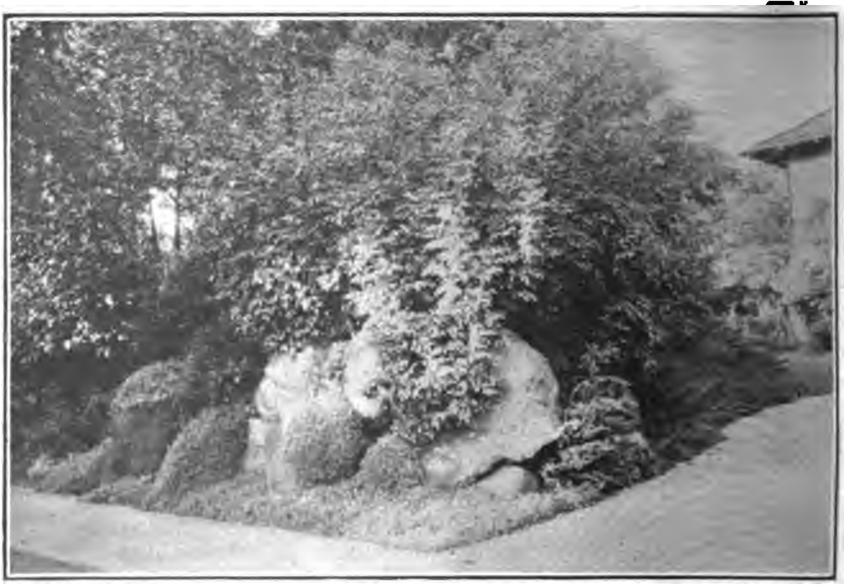

FIG. 40.—A bank held by rocks.

might be expended to increase them slightly. Steep banks are objectionable, as they are more difficult to maintain than moderate slopes. Wherever it is necessary to have rapid changes in grade, an effort should be made to accomplish it in the most natural manner practicable. If at all possible this should be by using a double curve, known to carpenters and landscape designers as an "ogee," which consists of a convex surface for the upper part of the slope and a concave surface for the lower part. Such curves may be either short and sharp, as shown in figure 38, or long and flat, as in figure 39. Where banks similar to those on railroad cuts or fills are necessary, they should be held in place by embedding rocks in the surface (fig. 40) when stone is available and planting among the stones or by setting out shrubs or vigorous vines (fig. 41), especially if the rock treatment is not practicable.

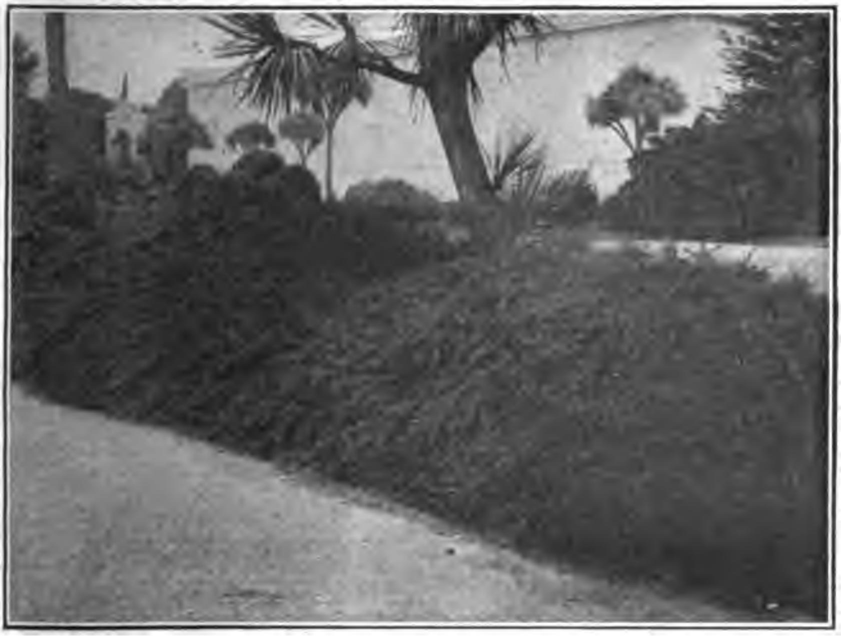

FIG. 41.—A bank held by vines.

Plane surfaces, either flat like a table or on a slope like a roof, are not desirable except in formal gardening.

The kind of lawn cover is important. The best for the region should be used, even if it requires a little more care to establish it. In most parts of the United States grasses can be utilized for lawns. In a few places other ground covers must be used unless great care can be given the lawn. Wherever it is at all practicable to grow it, grass is the most pleasing cover.

Lawns should be of sufficient size to give an ample setting, especially for the house. If well placed, 2,000 or 3,000 square feet may answer all purposes, although much more space is better. The apparent size of a lawn may often be materially increased by having a pasture adjoining it and separated by the most inconspicuous fence possible located in the least obtrusive position. (Fig. 20.) By care in scattering manure from time to time in order to prevent the grass from growing in clumps and by cutting weeds or grasses that tend to grow in bunches, such a pasture may be made a very attractive extension of the lawn, especially if it is provided with a few clumps of fine trees.

If the surface of the lawn is made reasonably smooth and it has been graded so that there are no steep banks, keeping the grass cut should be a comparatively easy matter. The finest turf is obtained by cutting with a lawn mower every 5 to 10 days, depending on the season. A small area can be cut with a hand mower or a larger one with a horse-drawn mower. If the time necessary to keep a turf smoothly shaven is felt to be greater than is justifiable, an ordinary field mowing machine may be used from once in two weeks to two or three times in a season. Of course this will not produce as nice a turf as would result from the regular use of the lawn mower, but it will keep the lawn neat and reasonably attractive.

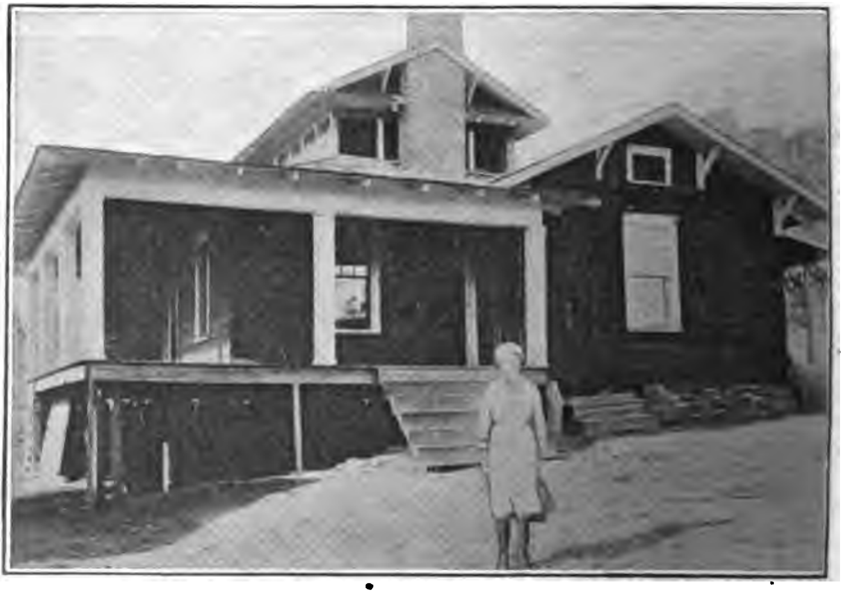

FIG. 42.—A good house, but bare and unattractive for lack of pleasing plantings. Compare with figure 43.

If cut every two weeks it may be possible to permit all clippings to remain on the ground. If cut less frequently the clippings will probably have to be removed after each mowing. Live stock should not be turned on the lawn to graze, as they will be likely to eat and trample the shrubbery as well as the grass. It is best to make a clear distinction between the lawn and the pasture extension, separating them by the most inconspicuous fence possible.

For a full discussion of the subject of grading and making lawns, Farmers' Bulletin 494, entitled "Lawn Soils and Lawns," may be consulted.

ARRANGEMENT OF PLANTINGS.

Although the discussion of planting is left until the last, it is not because it is of least importance in the development of an attractive farmstead, but rather to make more clear its true function. There is a widespread lack of appreciation of the importance of the matters already discussed, and a corresponding feeling that no matter how poorly arranged and designed a place may be it can be made beautiful by a few flower beds properly located. This idea of the power of plants to beautify is not entirely erroneous, but it is certainly exaggerated. Although they can greatly soften grave faults, they can not hide them. While even a well-designed farmstead is bare and unattractive (fig. 42) until properly united by plantings of trees, shrubs, and flowers (see fig. 43), on the other hand, plants may be so poorly arranged that they fail to add as much to the appearance as they might.

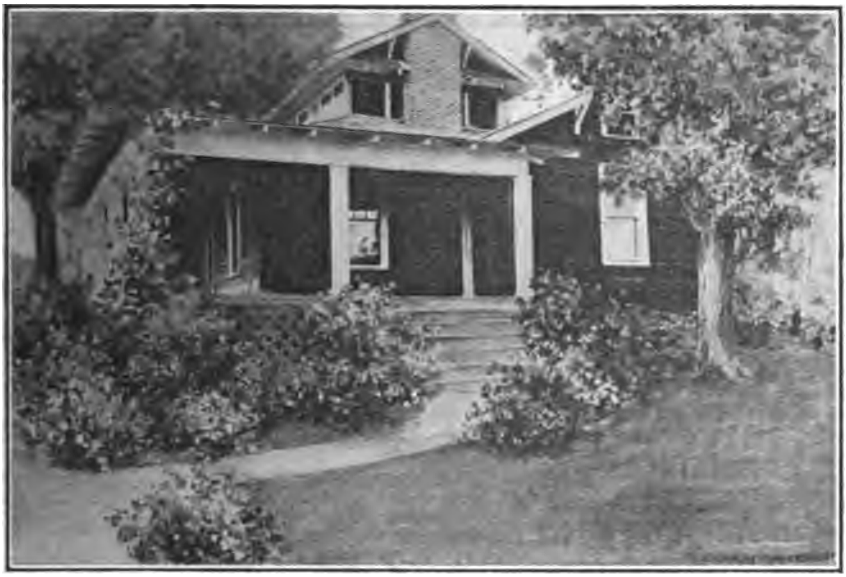

FIG. 43.—The house shown in figure 42 tied to its location by plantings.

Plant arrangement as well as the design of the grounds may be divided into formal and informal plantings. Formal planting is the arrangement of plants in regular order, either in straight lines or in balanced geometrical designs. This is true whether the effect is produced from the regular placing of individual plants or by massing several specimens of a kind. Such planting is only appropriate in a formal design, which on farmsteads would be in connection with long straight approaches or in formal gardens.

Informal planting is the arrangement of plants irregularly, more or less in the manner in which they are found in native woodlands and thickets, and they may be used singly or in groups of any size with any number of kinds. Planting of this kind is appropriate with either a formal or an informal design and is especially adapted to farmsteads and home grounds.

In formal plantings all the plants must be set and trained to conform to the design (see figs. 4, 16, and 36), while informal plantings should be placed irregularly and trained to bring out the individual characteristics of each variety, so that the result may be as varied, graceful, and natural as possible.

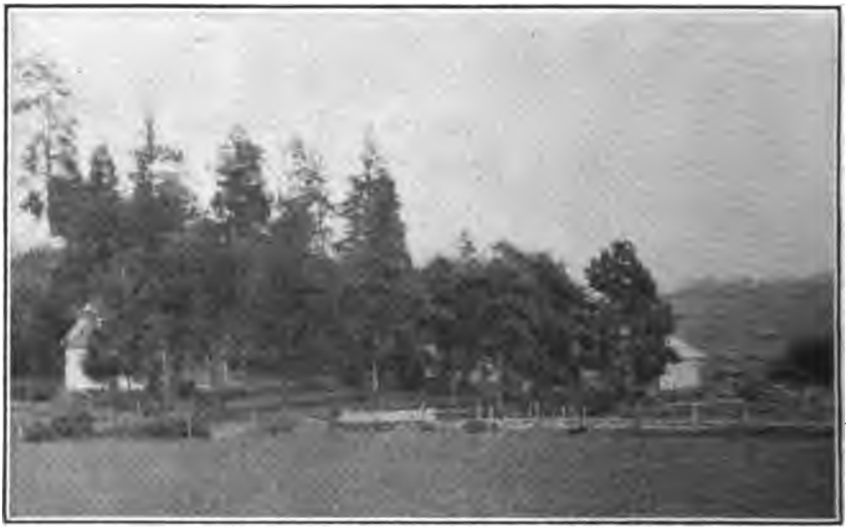

FIG. 44.—Trees about and between farm buildings, giving needed shade and partial seclusion.

TREES.

The first thought in connection with planting about a farm home turns naturally to trees to provide shade. Old places in the eastern part of the country, both North and South and in the Middle West, and the most homelike and best-developed places in the newer parts of the country have well-grown shade trees about the house and a few in the work yard between the house and barn. (Fig. 44.) Where a farm has been hewn out of a wooded country some fine old trees will usually be found in the stock pastures, and in a few cases of farms on treeless prairies some consideration has been given the live stock by providing trees in the cattle yards. The finer and better the trees about a farmstead the more the attention is likely to be attracted and the greater the impression of homelikeness. A single tree is often sufficient to make a place attractive. (Fig. 45.)

Trees, then, are of great importance in giving an attractive appearance to the farmstead as well as in making it a more enjoyable place in which to live by providing welcome shade and protection from undesirable winds. Trees should be planted with the possibilities of this twofold use clearly in mind. In most of the country north of the 40th parallel there is need of protection from the cold northwest winds of winter and also of shade about the buildings in summer. To meet the former requirement groups or clumps of trees should be so located that they break the force of these objectionable winter winds, while at the same time they occupy the least possible area of tillable land. In the hilly parts of this region many farm buildings are built in the lee of a rise of ground or close against the side of a hill, so that there is less need of shelter planting. In the eastern and extreme western parts of the country such shelter plantings would be more effective if made largely of evergreen trees, especially those which normally hold their lower limbs, but in the central Prairie and Plains regions the moisture conditions in winter are such that only the hardiest deciduous trees will succeed. Where such shelter is needed the buildings should be so located with respect to it that not only will the trees give the needed protection but also form a background or setting for the buildings from as many points as possible. In addition to the trees providing the shelter, smaller flowering trees can be used in front to give an added interest to the planting. In other large areas, particularly in the western part of the country, where protection is needed from the drying southwest winds, a similar use can be made of shelter plantings. It is often possible to transform an apparently barren waste

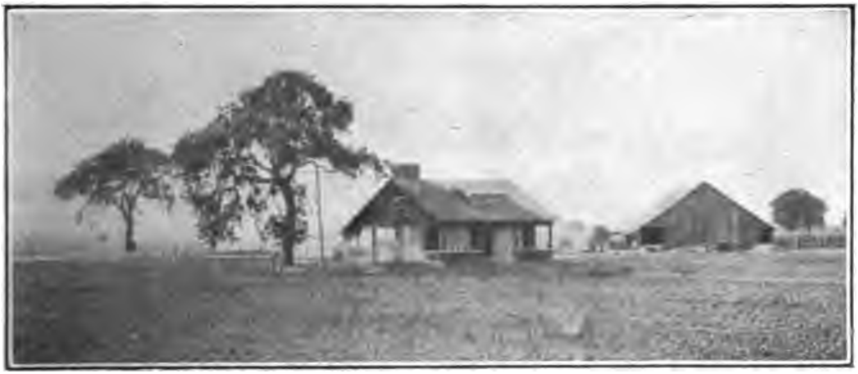

FIG. 45.—A single tree is often sufficient to make a place attractive.

into a region of productive farms and good homes by first planting shelter belts at frequent intervals (figs. 46 and 50).

Shade trees should be located with a twofold object in mind: (1) To provide shade during the hot season and (2) to make an attractive setting for the house. Although this is the order of importance in the life of the family, the trees would best be located having in mind, first, their value as a setting for the house and then the desirable points at which to provide shade, as they will give shade wherever they are set, but will only make a good setting when properly placed near the building. A sufficient number of trees should be used, however, to make enough shade to invite to outdoor life near the house. Trees should not be planted directly in front of the house, but they should be placed somewhat to each side so as to make a frame through which a view of a portion of the front is obtained. When the trees are grown they should partially shade the house without entirely covering the front. In the southern part of the country it may sometimes be admissible to plant large trees on both sides of the front, so that when they reach maturity their branches meet. This may only be done if the trees are of a very high headed variety, if they are trimmed so that a good view of the house is obtained beneath them, and if the house faces south. If it faces in any other direction, sufficient shade can usually be provided by some other arrangement. A common fault is to plant too many trees and plant them so close to the house that the shade is too dense and keeps out all the sunshine and much of the air. For this reason as well as for

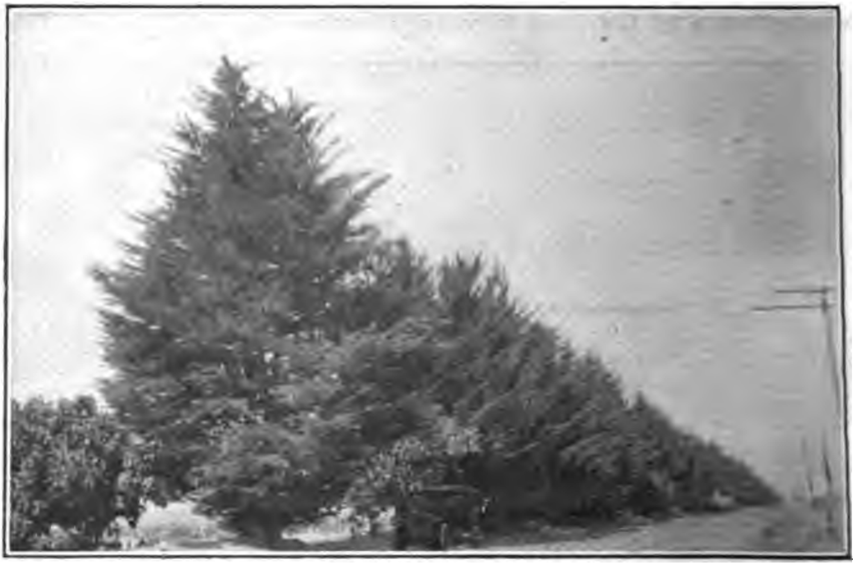

FIG. 46.—A windbreak that makes living more comfortable.

the sake of appearance it is desirable that the trees be so planted that at maturity their branches will not meet across the front of the house. (Fig. 47.)

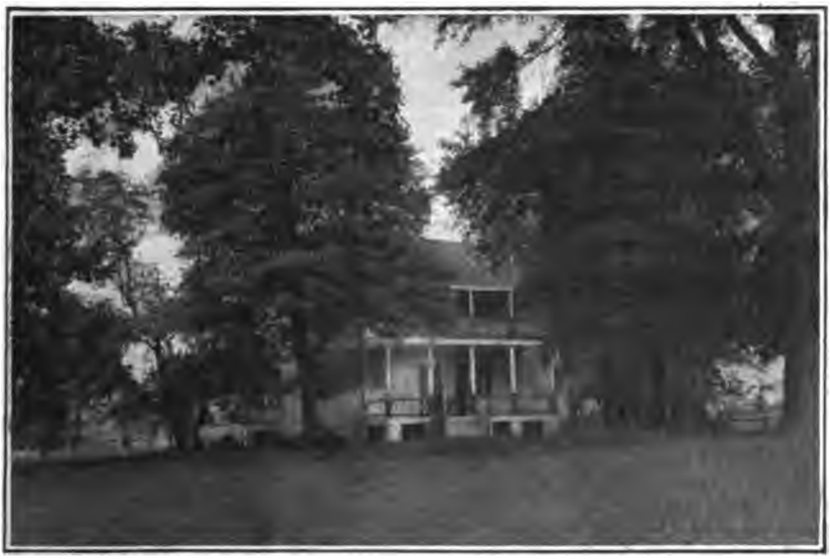

FIG. 47.—Trees partially hiding a house front.

It is usually desirable to have a large shade tree somewhere near the southwest corner of the house, as protection is most needed from the midafternoon sun. In some cases it will be best to place the tree on the west side; in others on the south; and again a group of

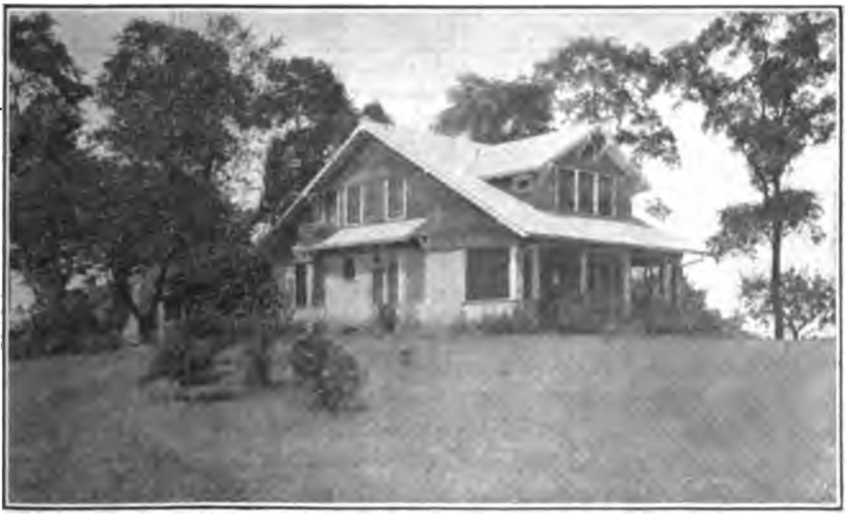

FIG. 48.—Trees at the back of the house form a frame.

them about the corner may be better. This may bring the trees to the rear of the house as a background (fig. 48) instead of as a screen in front. Not only should a portion of the front of the house be seen from the principal viewpoint, but there should be an open lawn in front of it. This lawn may be bordered on either side by plantings of trees or shrubs, or both, depending on the size of the place and the character of the development. If the lawn extends to the road, this side may also have trees, under the branches of which views of the house may be obtained. If the house is so far from the road that the lawn does not extend across the intervening space, it is usually inadvisable to inclose the road side of the lawn with trees, no matter how large it may be, as that would entirely hide the house from what would naturally be the principal viewpoints. Although it is desirable to hide partially the outlines of all the buildings, it takes from the interest to have them completely hidden. It may be advisable to have some trees on the road side of such a lawn, but liberal vistas should be kept open, so that some good views of the house are obtained.

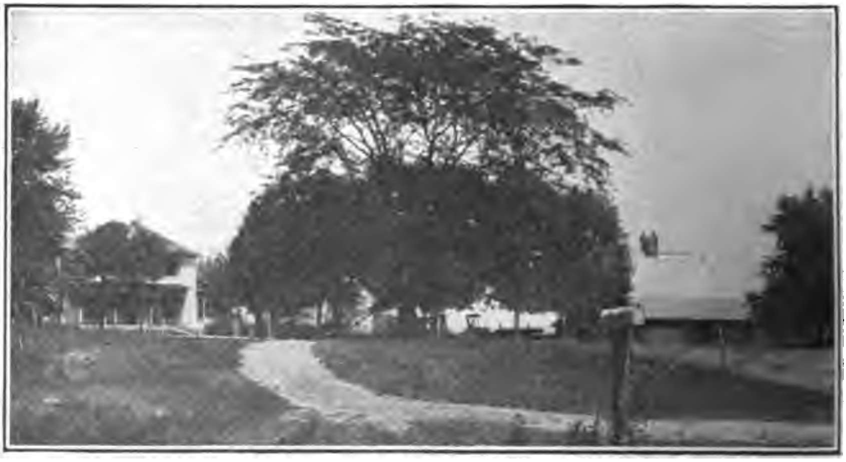

FIG. 49.—Trees partially hiding the front of a barn.

The house and its surroundings, as the home center and the most important unit of the farmstead group, has been emphasized in this discussion. The barns and other buildings should be so planned and located as not to overshadow and take from the interest in the house, even though they may be much larger. By a proper arrangement and the planting of trees and shrubs this can be accomplished without the sacrifice of utility or convenience. The barns, like the houses, usually can be partially hidden from the principal viewpoints (fig. 49) without detracting from their usefulness or wasting land.

It must be recognized, however, that this is not as easy to accomplish without interfering with other vital considerations as is the planting about the house. For example, with dairy and stock barns it is not, as a rule, possible to plant close to the south side, because of overshading the yards in winter, thus depriving the cattle of the full sunshine and also possibly making the yards a mudhole. In many cases the south is the principal viewpoint. Sometimes, however, trees can be planted to overhang the corners of the barn (fig. 49), or if it is not too high can be behind it, partially framing it in foliage. Here, again, care must be used both in selecting varieties and in placing them so that the tops will not interfere with hauling in hay and grain or the trunks interfere with other necessary work.

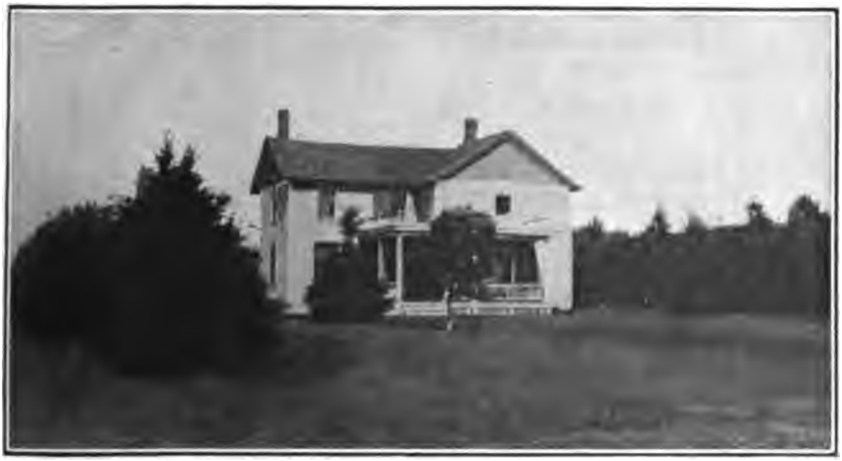

FIG. 50.—A screen of trees protecting the house from objectionable winds. The trees will ultimately form an attractive background for the house.

Paddocks are needed on almost all farms, and the inclusion of a few trees in the lot is helpful to the stock. When such paddocks can be located between the barns and the road their appearance can be greatly improved, while at the same time the land is fully utilized. Orchards frequently can be planned to help in the problem. It is not always easy to find the right solution, but when it is once realized that a barn unsupported by greenery is as much a blot on the landscape as a house so located, efforts will be made to bring about a better condition. Many of the obstacles will be found more imaginary than real, although there will be enough real ones left to require genuine, well-directed, energetic effort in order to solve the problem of making the farmstead homelike.

It is sometimes asked whether trees near a barn may not be dangerous by drawing lightning. They are much more likely to act as a protection, either dissipating what might otherwise be a lightning stroke or receiving the stroke instead of the building.

If well planned, this partial screening of the building can be largely accomplished by trees that are at the same time serving some other useful purpose in connection with the farmstead, such as giving shade in stockyards, pastures, or work yards. The windbreak or orchard may likewise serve a double purpose. In this planting it is not necessary to hide the buildings entirely; the aim is to make them less obtrusive by partially concealing them in foliage. The barns, like the house, should not be surrounded too closely by shade. This fault, however, is seldom found about farm buildings.

FIG. 51.—Evergreens add to the attractiveness of a home in winter.

It is often desirable to screen certain objects from view. (See fig. 30.) Tall plants are sometimes necessary for this purpose, and trees are the logical plants to use. Usually it is best to plant them as for a windbreak (fig. 50), although there are conditions when they may be planted as a grove to equal advantage. Such plantings are most effective when located near the object to be hidden, although there are times when a tree or two near the point of observation must accomplish the purpose.

The way these results are to be attained are among the important details of the preparation of the farmstead plan, and these matters must be considered in connection with the other details. In carrying out the plan one caution needs to be observed; that is, not to plant too many trees nor to have them too close together. When planted, the ordinary tree looks so small that it seems as though it could never fill the space provided. The result is that often more trees are added, thus making them too close when grown. Frequently trees are planted with the expectation of removing some of them, but when the time comes the home makers have become so attached to them that the inclination is to leave them a little longer and a little longer until the proper time for removal is past, the permanent trees are ruined, and still the temporary trees remain.

Except in the extreme South, only deciduous trees should be used for shade close to buildings, so that all the light possible will be available during the winter. At a distance of 75 to 100 feet or more from a building evergreen trees can be used either in some of the groups provided for shade or in the screen plantings. A few evergreen trees or shrubs give an appearance of life to plantings in winter and thus add materially to their attractiveness. (Fig. 51.)

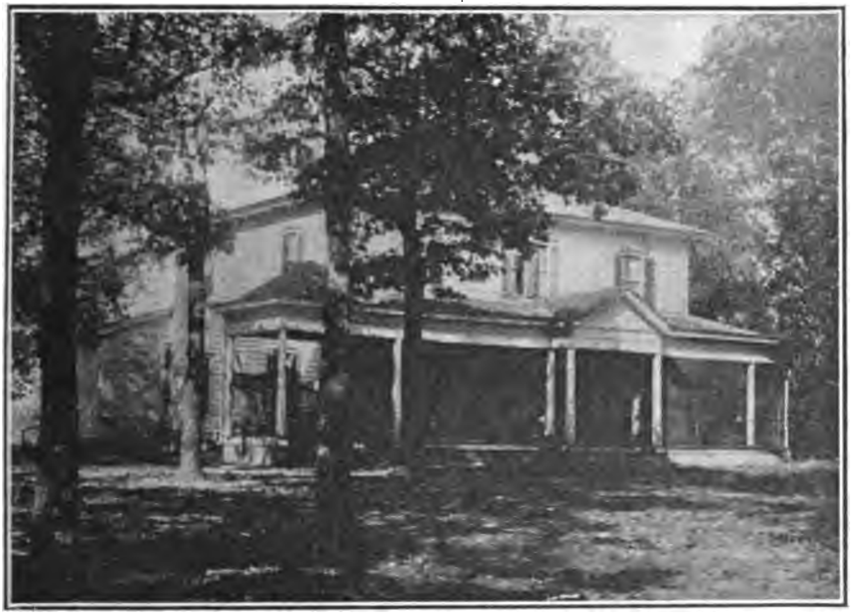

FIG. 52.—A farm home with good trees but without shrubs still looks bare. Compare with figure 53.

SHRUBS.

Trees alone, without the addition of shrubs and vines, will not give the best possible effect. A farmstead without such additional plantings will still appear bare and unfinished, as shown in figure 52. Many places are already well provided with trees, so it only requires the planting of a few shrubs to make very attractive looking homes. Besides having a portion of their tops hidden by foliage, the farm buildings also need to have much of their foundations hidden. The lines of a building are mostly straight and formal. To make these a part of an informal picture it is necessary to have the straight lines broken and disguised as much as possible. For this reason it is desirable to put masses of shrubs at various points around the foundations. (Fig. 53.) These plantings should vary in height and width, so as to hide and modify the straight lines instead of drawing attention to them. On the other hand, portions of the

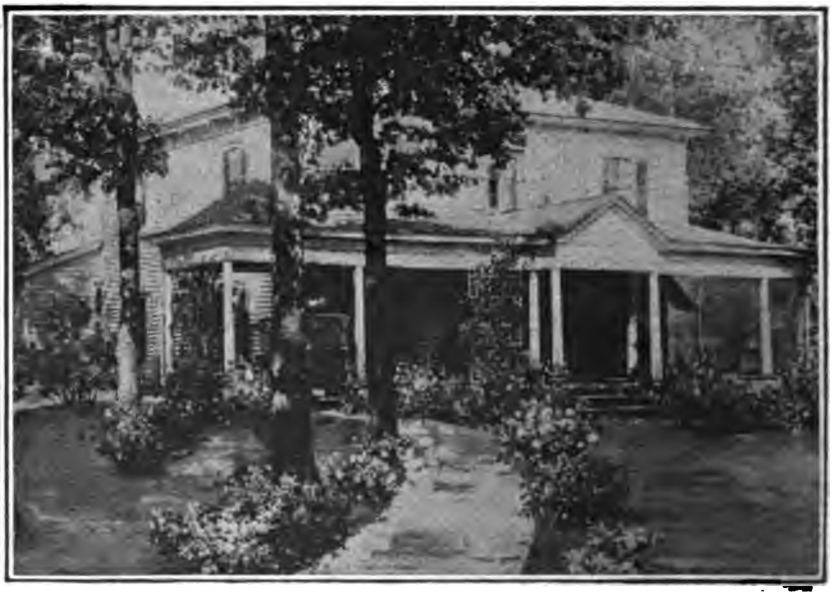

FIG. 53.—Masses of shrubs under the trees take away the bare look seen in the illustration of the farm home shown in figure 52.

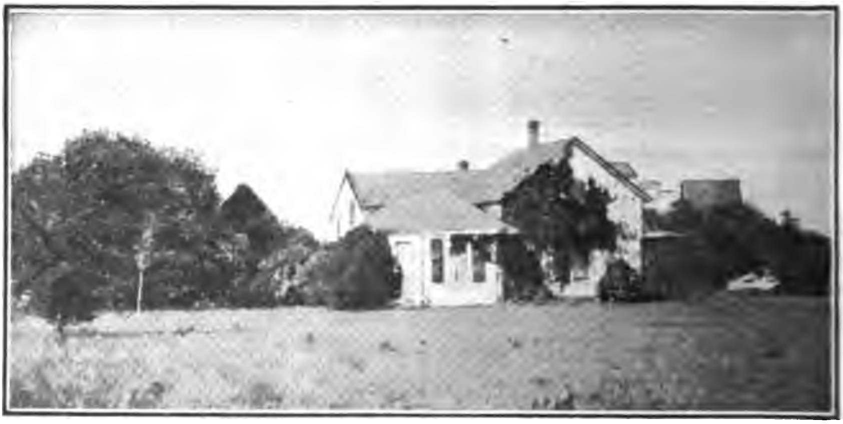

FIG. 54.—Buildings look appropriate when they rest in a mass of trees and shrubs. Additional trees are needed near the house as a setting and for shade.

foundation should be exposed and the lawn should be carried directly to these exposed portions, so that the building will appear to be supported. Success in planting is achieved when the buildings appear as though they belonged to the place and fitted naturally together and into the landscape. This is best accomplished by having them rest in a mass of trees and shrubs (fig. 54) while standing firmly on visible foundations. The corners are usually convenient places to plant with tall broad clumps, and these may often be extended into the lawns for a considerable distance. Angles formed by porches, by steps, or by an ell of the building are other points frequently utilized for such groups. Tall groups often may be used also against wide places between windows, while only low ones may be used under windows. Care must be taken not to have the different groups too much alike in breadth, height, and texture of foliage, or in "expression," as it might be called.

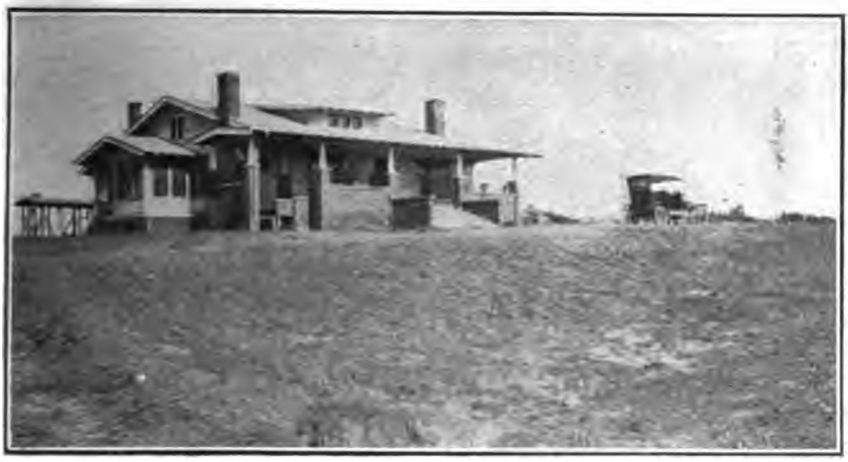

FIG. 55.—At this farm home there is nothing to clearly define the location of the road. Compare with figure 56.

To emphasize the feeling that the house belongs to the surroundings, the appearance of definite boundaries to the lawns should be avoided as much as possible. On most farms it is necessary to limit rather definitely the ground devoted to the home, but this limitation should not be made any more emphatic than can be helped. As already suggested, it is often possible to have the pasture or a meadow adjoin the lawn with an inconspicuous fence between. Another help to this impression is to disguise the actual boundaries by more or less continuous but irregular plantings along them. Where it is possible, distant views or near-by landscapes should be made to appear as though they were a part of the grounds. Much can be accomplished to this end by proper location of the tree and shrub groups on the boundaries of the home lot. Openings should be left in the plantings to expose the desirable view from the windows of the most-used rooms, the porches, or portions of the lawn, and plants of suitable size and height should be used to hide the less desirable outlooks. If there be a broad view, it is usually made more interesting by being divided into parts, as 30°, or one-twelfth of the circumference of a circle, is about as much as the eye can see at one time, and this is as much as should be included in a single view of a distant landscape. If it is necessary to inclose the home lot, the most inconspicuous wire fence possible is desirable, although sometimes a fence covered with vines or a hedge is better. As fences or hedges accentuate the boundaries, they usually should be avoided and when used they should be made to attract as little attention as possible. Their tendency is to give a "penned-up" feeling rather than the feeling of freedom that especially should be associated with the country home.

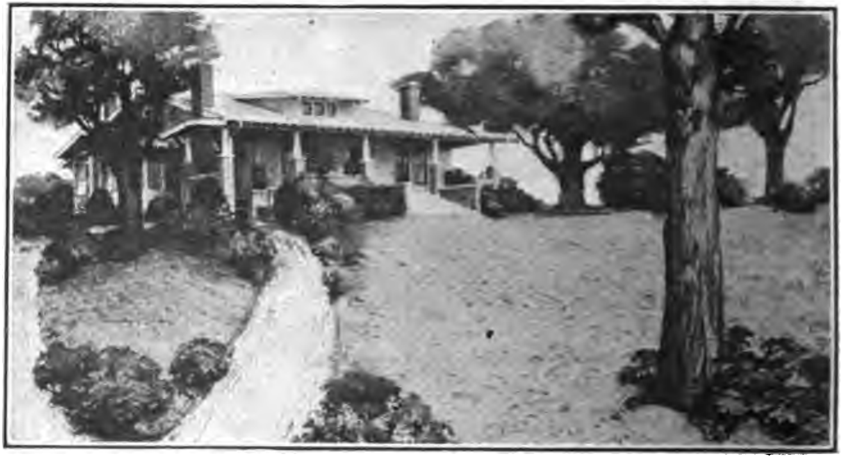

FIG. 56.—Shrubbery on the grounds of the farm home shown in figure 55 indicates the location of the road and provides a reason for the turns.

Shrubbery is also used to help outline the course of walks and drives and give an apparent reason for the turns (compare figs. 52 and 53; also figs. 55 and 56), and to make the surface less conspicuous by hiding it from many points. Such shrubbery must not be so high that persons in automobiles or other vehicles can not see others approaching around turns or so that vehicles and pedestrians are hidden from one another at the intersection of walks and roads.

Besides being used on the boundaries to screen less desirable views, shrubs are also useful as screens within the grounds either to hide objectionable views or to give privacy (figs. 57 and 58). It is sometimes well to shut off views between the barns and the house or between buildings and the highway, or even to give privacy to a work yard or a flower garden. Shrubs will often do as well as trees for a low windbreak. Besides the utilitarian screening just outlined, interest may be added by partially hiding one part of the grounds from another, simply to pique curiosity. If the whole of an object

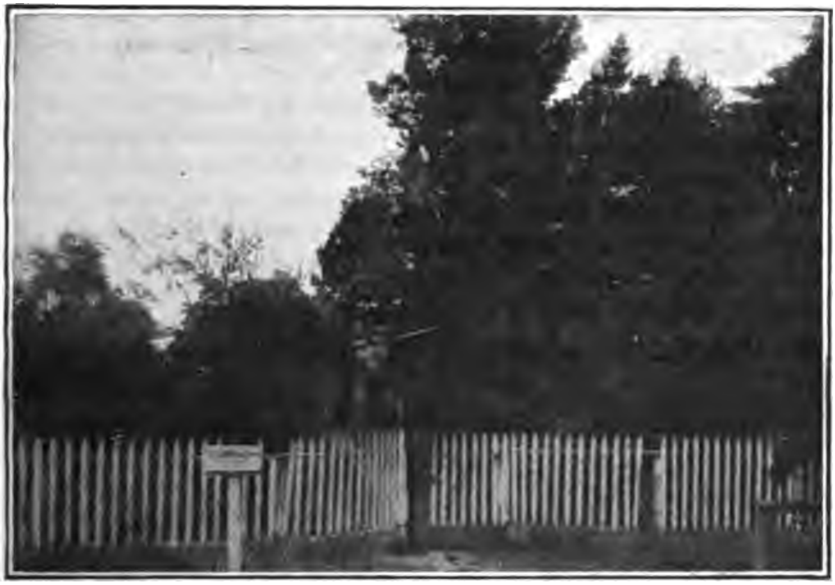

FIG. 57.—A screen to give privacy. Figure 58 shows what is behind the screen.

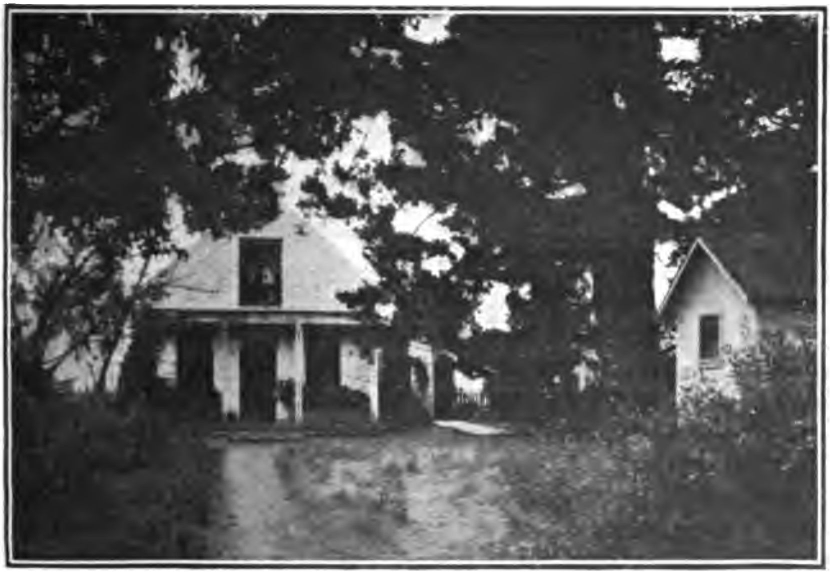

FIG. 58.—The farmhouse behind the screen shown in figure 57.

is seen at one time curiosity is satisfied and interest in it is gone, but if part is hidden it invites exploration. This is another reason for extending occasional points of plantings into the lawn, either from border plantings (fig. 59) or from foundation plantings. Narrower plantings on either side of such points will leave bays whose depths can not be seen without further inspection. In the same way a clump may be used occasionally to excite interest by partially hiding a portion of the grounds. Not many such groups can ordinarily be used. There is danger of dwarfing the apparent size by such planting, especially on small grounds, unless great care is observed in so locating the shrubs that they do not obstruct what would otherwise be good vistas. Such clumps must have some apparent connection with other plantings. They should either seem to be a part of the border plantings, of the base plantings, or of the plantings along the drives and walks. A bed alone in the middle of a lawn detracts from the appearance instead of adding to it.

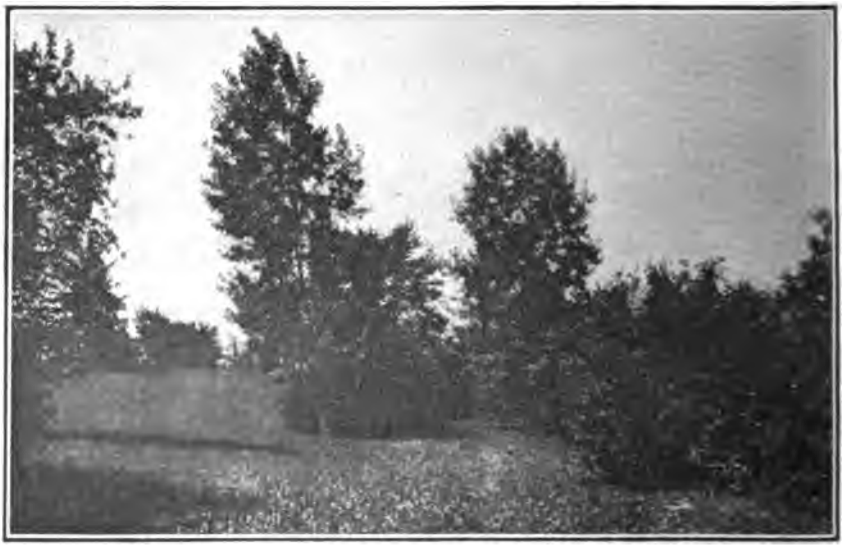

FIG. 59.—Promontories on border plantings.

An individual plant seldom can be used to advantage. Where a small mass is desired and a shrub has the size and habit required to fill that particular need, then a single specimen may be used. Occasionally a shrub can be set just in front of massed plantings in order to give variety, but as a rule this result can be obtained better by combining the shrubs differently in the groups.

VINES.

Vines are among the most useful plants for "tying" buildings to their surroundings. There is a freedom and grace about their growth that helps to relieve the formality of buildings or fences better than almost any other plants. (Fig. 60.) Care in their selection is necessary, however, as there are disadvantages in the use of some vines under certain conditions. On brick and stone buildings some of the clinging vines are most appropriate. An erroneous impression that such vines are injurious to the walls or make them damp exists in some quarters. This is true to the extent that they may keep the wall shaded and cool later in the spring than would otherwise be the case and so cause plaster applied directly to such walls to "sweat" in little used and insufficiently ventilated rooms. The difference between vine-covered and noncovered walls is in the time when this sweating process takes place. The leaves of such vines have somewhat the effect of a roof in keeping much rain from reaching the wall, and the aerial rootlets have a tendency to absorb the moisture that might get under the leaves. Where the construction is defective they may at times find crevices between bricks or stones and thus reveal poor workmanship, but rain and frost will do that as surely as the vines. On wooden buildings the problem is somewhat different. Many vines that climb by twining will force their way through any joint that is not perfect and then by continued growth force the woodwork apart. Many other vines do not have this injurious effect and can be used appropriately.

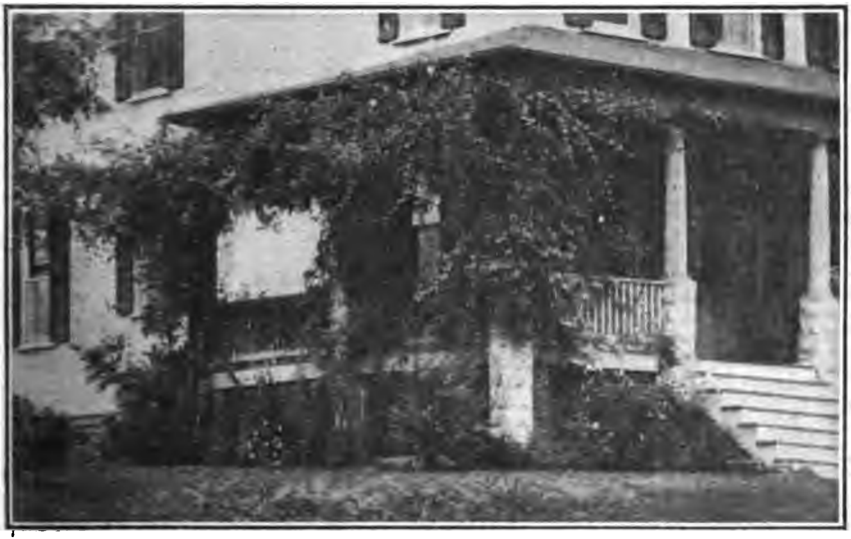

FIG. 60.—Vines help to relieve the formalities of buildings.

The great problem is so to train the vines that they may be removed to permit proper painting of the woodwork when that is necessary. This may be done by means of a trellis hinged near the ground or a chicken wire placed over hooks at the highest point, so that it may be removed. A trellis can be made of chicken wire on a pipe frame that will keep vines entirely away from woodwork. The thought is sometimes expressed that vines cause woodwork to rot. This is true if they are permitted to become so thick as to prevent proper ventilation and timely painting. Hot sunshine, however, is one of the most destructive forces in the life of paint. Vines by their shade help to preserve paint instead of destroying it.

Besides being appropriate on porches and on trellises against frame houses and on the walls of brick or stone houses, vines are also appropriate on fences, arbors, and pergolas, or on summer houses connected with the pleasure grounds or outdoor living sections of the grounds.

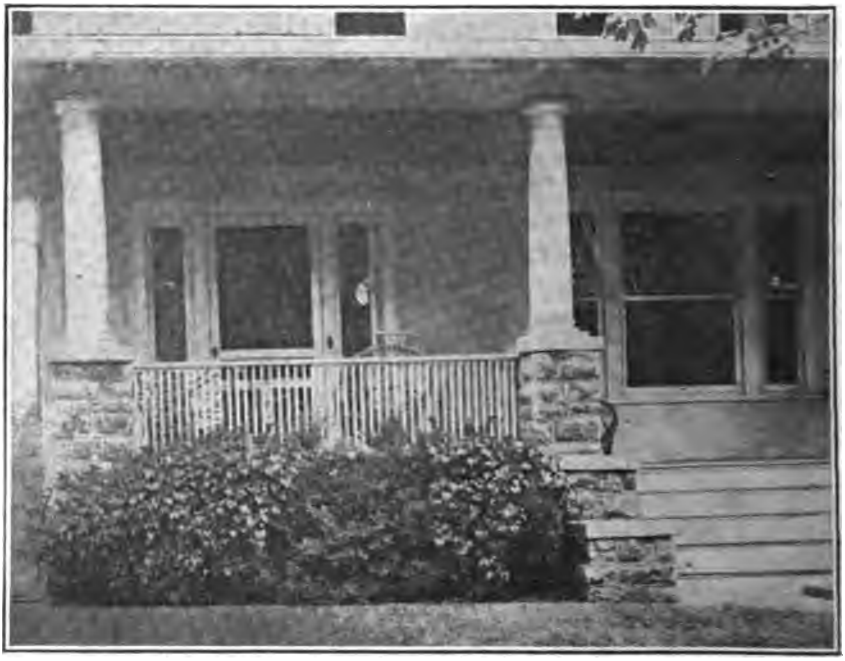

FIG. 61.—Scarlet sage in front of hemlocks.

HERBACEOUS PLANTS.

Besides the plants already suggested for the principal plantings, the herbaceous perennials and the annual flowering plants offer a large amount of material that is very useful to add bloom and color where these may be lacking. Little bays or pockets may be left between the shrubs, especially near the borders of the clumps, that can advantageously be filled with hardy perennial plants that give bloom at a time when the shrubs are lacking in bright colors. As a rule the period of bloom of these plants is not much longer than that of the shrubs, but many have extremely bright colors and these can be placed between the other plants where they will not take much room and will help to make a continuous picture. Most perennial plants will last three years or more without need of lifting and resetting. The spring-flowering bulbs, such as tulips, hyacinths, and narcissi, can also be scattered among the shrubs and be permitted to remain there and bloom for several years. Of these the narcissi are much the best adapted to this treatment.

Annual flowering plants can also be scattered at various points along the shrubbery beds and so provide color at a time when it is almost entirely lacking among the other plants. The tender bedding plants, such as cannas and geraniums, may also be appropriately used in the way shown in figure 61, where plants of scarlet sage have been used in front of some hemlocks, making a striking combination that could easily have been overdone. Such material should be used in moderation and in small clumps, never as continuous borders either to shrubbery beds or to beds along the house except in formal gardening. Beds of such material should not be planted in the open lawn. If that sort of planting is desired a formal garden should be provided where the planting can be done appropriately.

Tenants leasing from year to year or others expecting to be on a farm for only a few months can bring about much improvement by planting annuals and tender bedding plants in the manner described for shrubs.

PLANT MATERIAL.

In planting the farmstead the particular plants used, if hardy and adapted to the region and locality, are of less importance than the general effect of the mass. The expression of the mass, however, is dependent on the combined effect of the characters of the plants composing it. There are great differences of expression between the exclamatory or "look-at-me" impression created by the Lombardy poplar and other tall slim plants and the sympathetic and almost mournful impression given by drooping plants, like the weeping willow; between the sturdy self-reliant attitude, typified especially by the white oaks and live oaks, and the dependent or clinging attitude expressed by vines; between the formal expression of symmetrical rigid-growing plants, like the firs and spruces, and the informal expression of the tamarisk; and between the heavy effect of plants with large dark leaves and the airy effect of plants with small light-green leaves.

Plants with great differences of expression should not be used too close together, but should be united by those with intermediate characters. The lines of the different parts of the mass should flow into one another without too great contrasts. Transitions in color and texture should also be gradual. The more unusual the characters of a plant the greater is the need for carefully placing it where it will be most pleasing.

Plants selected for home-ground ornamentation should be hardy in the region, should be comparatively free from attacks by insects and diseases, should have a reasonable quantity of foliage that is not liable to drop from slightly adverse conditions, especially weather conditions, and should be of the proper size, habit, and texture for the location; that is, where a tall upright shrub is needed a tall spreading one should not be used. Most of the planting should be of comparatively few kinds, although a few specimens of unusual sorts will give variety and add a certain amount of interest. The characters of plants that make them valuable for adornment are (1) foliage, (2) winter effect, and (3) flowers. The importance of foliage is due to its permanency, lasting from five months to a year, depending on the type of plant, the latitude, and the elevation, while the period of bloom is short, usually not more than two weeks.

Next to foliage in importance comes the winter effect. Taking the United States as a whole the average time that deciduous plants are without foliage is at least five months. During this period the farm home is occupied as continuously as in summer, and the surroundings should be as attractive as possible. Evergreen shrubs, both coniferous and broad leaved, maintain a color throughout the winter not otherwise obtained. Used in moderation, they are a distinct addition at this season. On the other hand, many deciduous shrubs have attractive winter characters, the most striking being bright-colored berries. Then there are barks of many shades of brown and gray, with some of bright red, green, and yellow, that if properly arranged make pleasing contrasts and add to the winter beauty. The short blooming period of the average shrub makes flowers the least important of the characters to be considered. In spite of this the color, character, and time of blooming should be considered as well as the behavior of the dying flowers, whether or not they fade to a conspicuous and undesirable color and hang on unduly or pass away without a distinctly unsightly stage.

The different kinds of plants should be selected so that they will give bloom through as much of the season as practicable, thus affording something of special interest as continuously as possible. The bulk of the planting, however, should be of a few species. Eight to a dozen kinds are enough for an ordinary place. With this small number, selected as far as practicable to bloom at different seasons, there is little danger of getting color combinations that will not harmonize. Where especially bright colors are selected, others should not be chosen for growing next to them during the same season unless they harmonize. Near brick buildings, or buildings painted with bright colors, care must be exercised in selecting shrubs with colored flowers. White flowers are always safe and can be used to help in giving other flowers an appropriate setting. A plentiful use of the different greens or a mixture of many colors is also safe. It is only when one or two colors are selected for use in quantity that danger of lack of harmony arises.

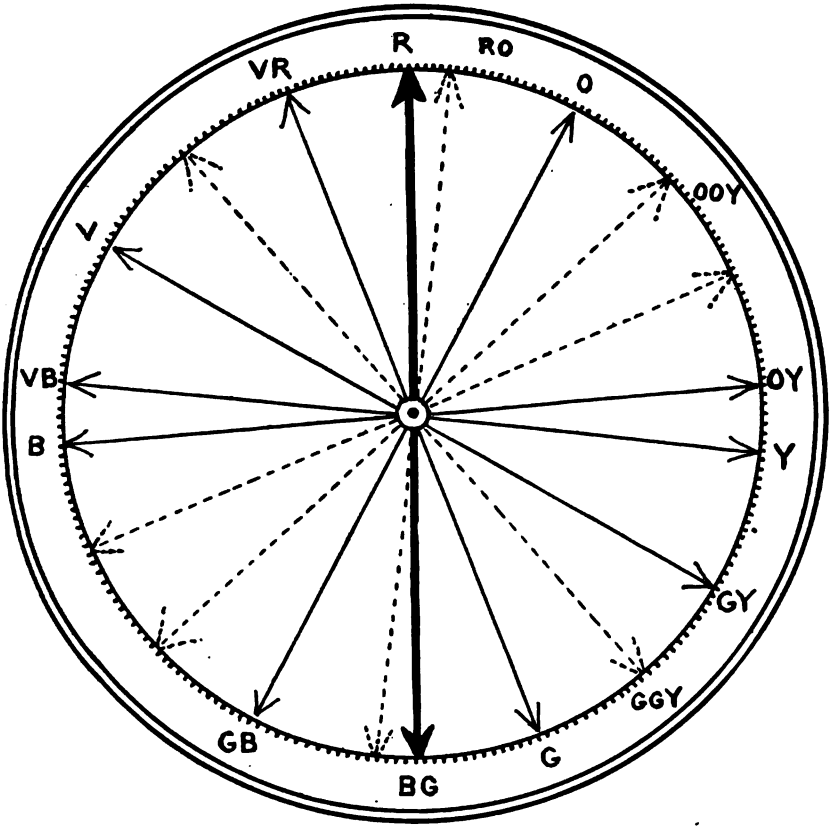

Fig. 62.—A chart showing the appropriate color combinations for highly colored flowers. Colors immediately adjacent to one another on the chart, or those opposite or nearly opposite one another, are apt to harmonize and are therefore safe to use together. Those at right angles to one another are liable to be discordant, and should not be used together by those not thoroughly familiar with color harmonies and the possibilities of color combinations. *B*=blue, *G*=green, *O*=orange, *R*=red, *V*=violet, *Y*=yellow.

The reason that white is a safe color to use is because the human eye can observe it with least fatigue. It is composed of a mixture of the colors of the rainbow. Theoretically, each of the rainbow colors can be combined with some other color and produce white, although in practice it is a dirty white or light gray. Two colors that can be combined in this way are spoken of as "complementary colors" and are shown opposite one another in figure 62. If a bright color is looked at intently for several seconds and then the eyes are closed the first impression is that of the complementary color. In practice, it is found that if with a large mass of bright color the complementary color is used or some of the colors near it on the chart, the result is restful to the eye and the impression pleasing. On the other hand, the impression is unpleasant if the colors indicated on the chart midway between the complementary colors are used with either. One who is sensitive to colors and makes a study of flower colors, however, can often successfully make daring color combinations that should not be attempted by those not experienced and not color sensitive. In ordinary planting it is good practice to use a color with those colors near it on the chart or with its complement on the opposite side, avoiding those shown at right angles. The colors found in any botanical species are safe to use together, but flowers of different species or hybrids of them, though of the same genus, are not always safe; as, for example, not all kinds of roses are suited to grow together. Where the aim is to get thrifty growing plants about the farmstead rather than to make the most striking display possible, there is little danger of making an inharmonious combination, as nature with its preponderance of green tends to avoid a too garish display.

In addition to locating clumps of shrubbery at appropriate places on the grounds, the placing of the various kinds of plants in the clumps has an important relation to the ultimate results. It is usual not to plant many clumps of a single kind. A mixture of plants of similar size in each clump gives the best results. One clump may be composed of one-half of one variety, one-fourth of another, and the rest of other kinds, while another can be nearly equally divided between two kinds, and still another can be three-fourths of one kind and the remainder of any other combination. Where a large quantity of one variety is used in a clump, it is well to have at least a few of the same plants in some of the near-by groups. In nature, trees and shrubs are mostly found in large quantities, either almost alone or well mixed with other plants. As the boundaries of these areas are reached, the plants are found in more or less scattered clumps, until the place is reached where there are none. In a similar way the plantings should be in comparatively large masses with scattered plants in other near-by clumps, as shown in figure 63, where the arrangement is indicated by different numbers for different kinds. The plants should be set at irregular distances apart, so as to avoid being in lines in anv direction.

By making a few clumps largely of one kind of shrub and by scattering plants of it in others, the impression may be given of the yard being full of this plant when in the height of its bloom.

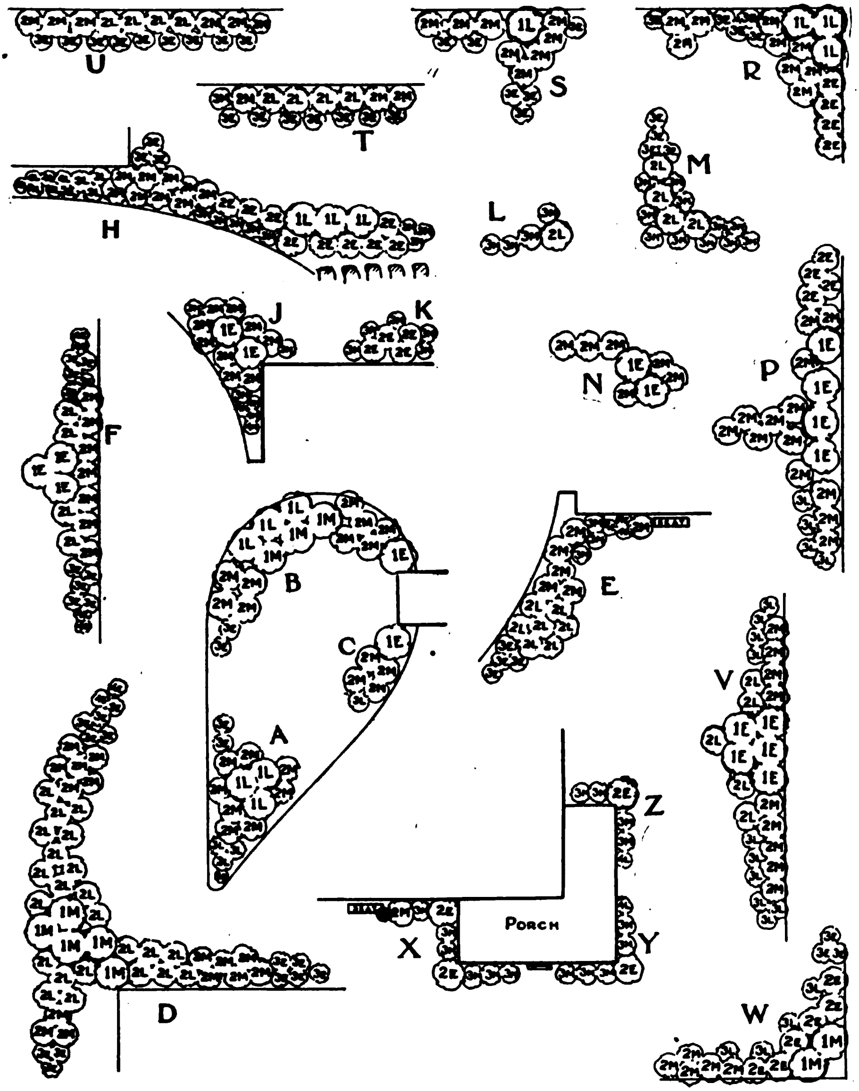

Fig. 63.—Sketch showing the plant arrangement in the groups illustrated in figure 28. The number signifies the height of the shrub: 1=large, 10 to 15 feet; 2=medium, 6 to 10 feet; 3=small, 2 to 6 feet; 4=low, 1 to 2 feet. The letter signifies the period of bloom: E=early, M=midsummer, L=late.

Then, by having another shrub predominate in other clumps with more scattering plants a similar impression may be created for another plant at another season. Other kinds can then be restricted to limited portions of the grounds. If for any reason it seems desirable to use a certain shrub only in one particular clump, this clump can be made to appear to belong to the rest of the planting by including in that mass a specimen or two of the shrubs predominating in the adjoining groups. Most clumps need plants of different heights, the taller ones at the back, the shorter in front, and plants of any height may be used for "tying" them together. More than one height of plant may often be used for this purpose.

The kind of plants to use is of less importance than their location upon the grounds. In all sections of the country there is native material that is more desirable for local planting than most of the plants brought from other places. The more trying the conditions for plant growth, the more important it is to secure native species and stock of the commoner things that have been grown from seeds or plants gathered near home. There is wild material in every neighborhood that is more suitable for planting in that locality than nine-tenths of the plants described in the catalogues. This is as true of the dry-land country just east of the Rockies and the semiarid regions of the Southwest as of the more moist regions. Search along the streams, on the hillsides, on the plains, in the

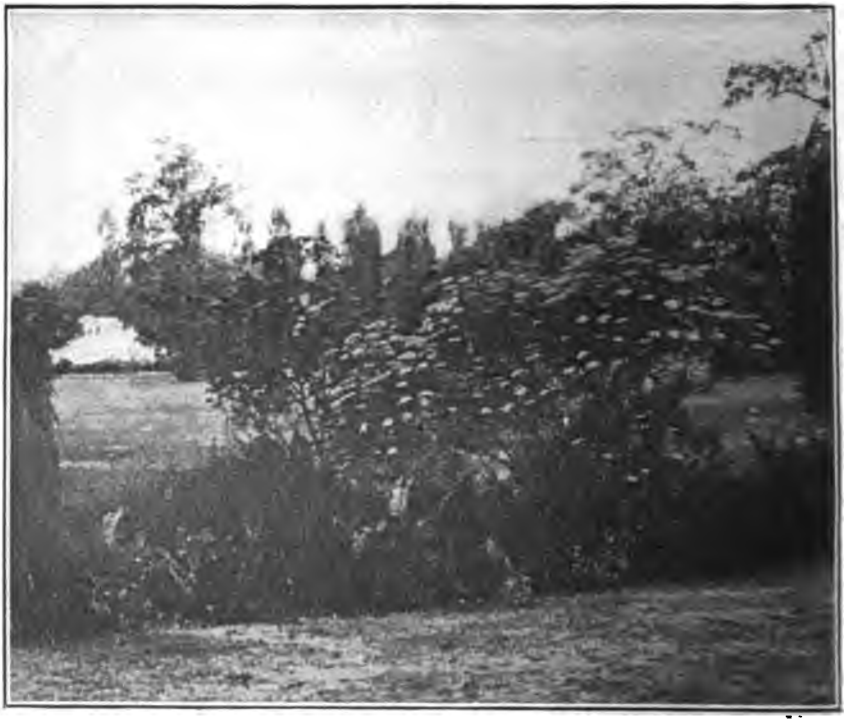

FIG. 64.—A handsome native shrub, the elder. It grows nearly everywhere in the United States.

woodlands, draws, arroyos, or canyons will reveal the attractive things that are close at hand. Europeans recognize the value of many of these plants, collect them and grow them a few years, and then introduce them to us. The common wild plants of any neighborhood should be largely used for home planting. Although many may be so common they have gotten in the way of cultivation, still they may be beautiful and have value for ornamental planting, as shown in figure 64. Nearly all improve with culture. Where possible to collect them from their native habitat there is a satisfaction in the final results that is not obtained from purchased material. Those collected in the vicinity are usually more difficult to transplant successfully than the same sort of plants purchased from a nursery. This is because in the wild the roots have never been pruned and so have run to long distances, with the result that when the plant is dug a much larger proportion of the roots is cut off than when taken from a nursery where they have been root pruned frequently. To correspond to this more severe root pruning the tops must be more than correspondingly cut away. This will seem like destroying the plant, but the important part of such work is to secure a vigorous root system that will put out new growth rather than to obtain a ready-made top. The more trying the climate for plant growth the more severe the top pruning should be. Besides the loss of a large proportion of the roots, failure in moving native plants comes from lack of sufficient care in keeping the roots moist

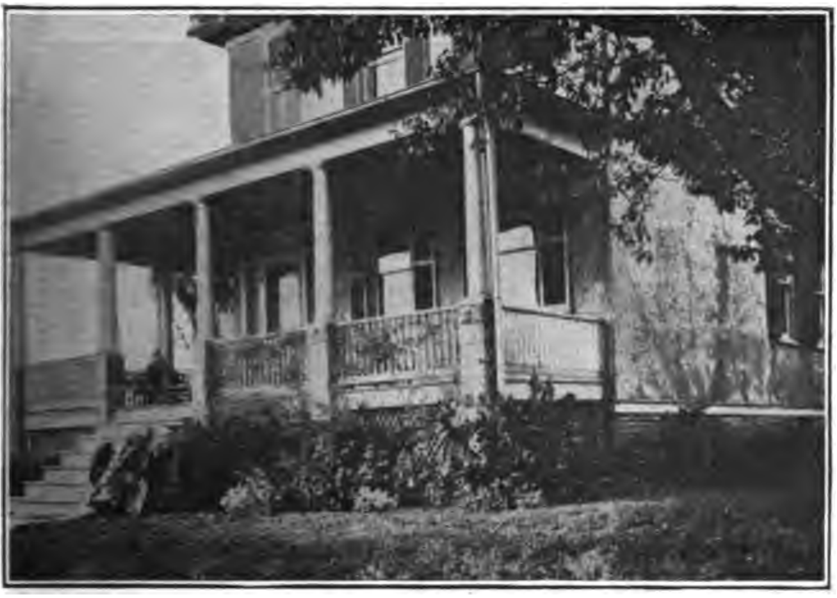

FIG. 65.—Shrubs with temporary plants set between.

from the time they are dug until they are replanted. The roots should be kept covered with wet packing material from the time they are exposed to the air until they are again set in the ground.

If the plants are to be purchased, a reliable nurseryman, located where the climatic conditions are as near like the local conditions as possible, should be selected. The stock should have been produced from seeds or cuttings grown near home rather than from plants grown under different climatic conditions. The reason for this is that the plants will be likely to be hardier and be better adapted to the local conditions. A partially tender plant is always unsatisfactory.

There are two methods of setting shrubs for ornamental effect: One is to set them as far apart as they should be when they reach maturity, and the other to set them more closely and from time to time remove some of them. With the first method (fig. 65) it is necessary to use annuals or perennials between the shrubs for several years in order to have the beds and clumps filled. This usually does not entail much extra work, as such plants are frequently wanted at some point on the grounds or in the garden for their bright summer effect. The difficulty with the second method is that the thinning is not likely to be done as soon as it should be (fig. 66). Where only part of the spaces set aside for planting are ready, the plants for all the spaces may often be put where the beds are prepared, and then the extra plants can be taken to the place designed for them as soon as the beds are ready. In this way, too, it is possible to start with smaller, cheaper plants than where an immediate result is desired with permanent plants only.

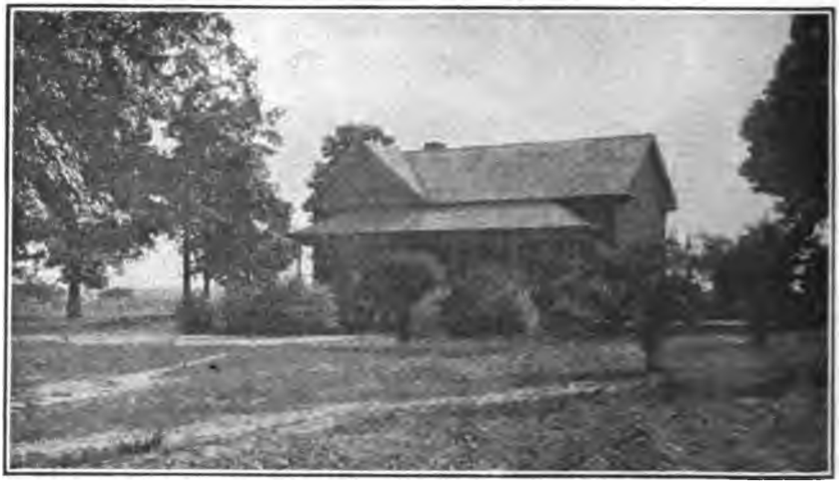

FIG. 66.—Shrubs help to make a house seem homelike. Although these shrubs are massed too much in front of the house they add greatly to its appearance.

After trees and shrubs are planted they will need hoeing and manure for two or three years until well established, when they can, for the most part, take care of themselves unless rapid growth is a consideration; then the manuring and cultivation should continue. After becoming established they will need no pruning further than to remove dead or broken wood. If a mistake is made in the original selections, so that plants of a wrong size, habit, or texture are placed at any point, no hesitation should be felt about correcting the error by removing them and putting appropriate plants in their place.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. March, 1920

A HOME and its surroundings must be attractive in order to be most uplifting to the family, visitors, and passers-by.

Farmsteads especially need attention in order to secure satisfactory conditions. The farm home and the farm business are so closely related that the success of the latter is reflected in the appearance of the former.

All the buildings with their immediate surroundings must be considered. The roads and walks; the home vegetable, fruit, and flower gardens; the lawns; and the ornamental plantings are also important factors in determining the plan.

Each building needs sufficient land about it to give it a proper appearance and provide the necessary yards or work room, and each should be so located with respect to other buildings as to facilitate the work of the farm.

Roads and walks should be limited to the number necessary to facilitate daily traffic.

Vegetable, fruit, and flower gardens must provide liberally for the family needs.

The lawns should be so located and of such size as to give a pleasing setting for the home, but not large enough to make their care burdensome.

Suitable plantings are necessary to unite the parts of a farmstead into a pleasing, homelike whole. Trees are used for windbreaks, as frames for the buildings or a background for them, and to give shade. Shrubs are needed in abundance to hide partially the foundation lines of buildings, support their corners, give reasons for turns in drives or walks, and to screen unsightly objects. Native trees and shrubs and those known by trial to thrive in the locality are the best to use.

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1087

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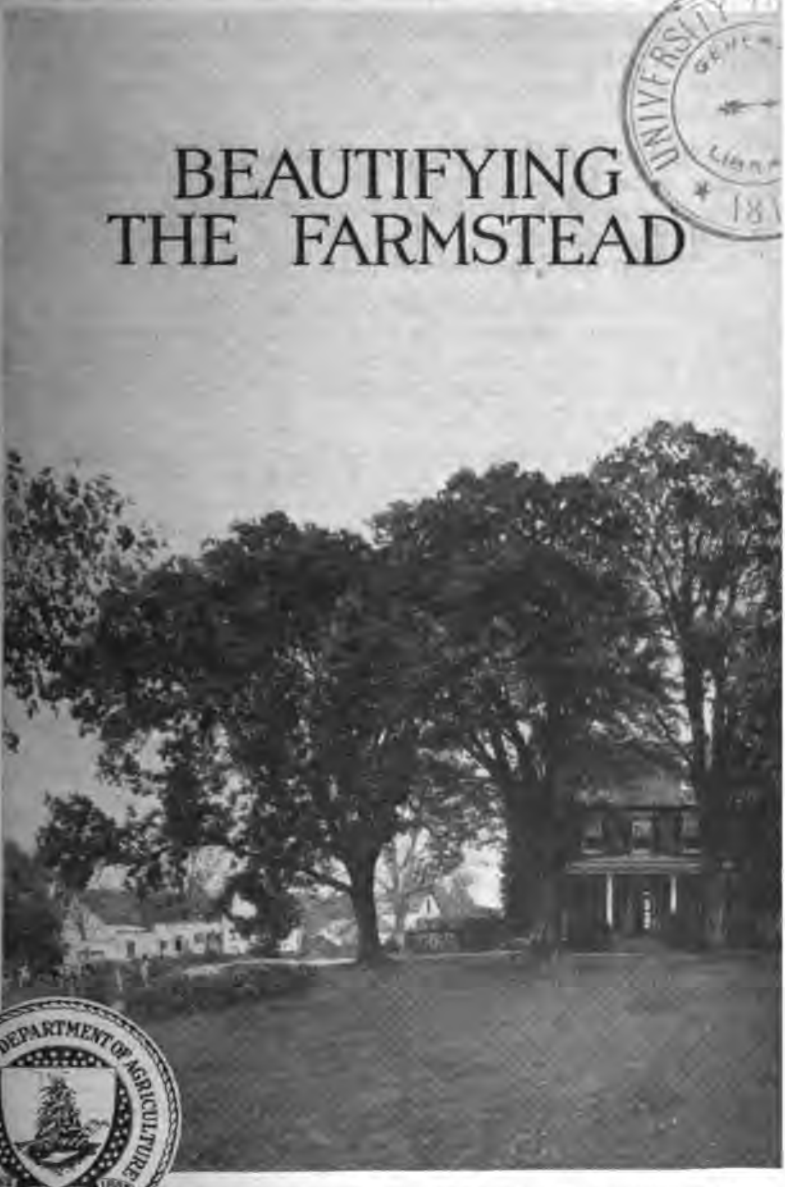
BEAUTIFYING THE FARMSTEAD



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Native trees and shrubs and those known by trial to thrive in the locality are the best to use.

Washington, D. C.   Issued March, 1920; revised, November, 1929

BEAUTIFYING THE FARMSTEAD

By Furman Lloyd Mulford, *Associate Horticulturist, Office of Horticultural Crops and Diseases, Bureau of Plant Industry*

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NEED OF BEAUTIFYING THE FARMSTEAD

HOMES are the foundation of a nation. With clean, attractive, pure homes the youth become strong, upright, honorable citizens. Anything that will make the home better will tend to improve citizenship.

The essentials of a good home are a man and woman resolved by their mutual efforts to make this world a better place in which to live and a structure that will protect life and health from undue exposure to the elements. If the dwelling is to be really a home it must be more than a place at which to eat and sleep. (Fig. 1.) It must be for the mature a haven of rest from vexations incident to breadwinning and other serious duties of life and for the young a retreat for the solution of life's problems. Inspiration to better living must be there, incentive to strive diligently for the highest ideals; and to attain these ends not only must the physical needs of the family be supplied moderately well, but the home must be attractive. (Fig. 2.)

The foundation of this attractiveness is love among the members of the household, combined with a right moral, mental, and religious attitude. This attitude is greatly influenced by the surroundings. Sufficiency of food and exercise with other physical comforts in moderation are conducive to the highest development, while marked deficiency or excess of physical comforts is debilitating. Beauty in every form has an influence for good. Forms of beauty differ greatly in their effect on persons. Children, especially, are wonderfully affected for good or ill by their surroundings. The greatest influences are probably seldom realized at the time they are exerted.

The efforts of women to make homes attractive usually include the immediate surroundings of the dwelling. In suburban communities and in cities that are not too closely built up, men are cooperating more and more actively in the development of home grounds and often take the initiative. On farms the little attention that is given this matter is often contributed solely by the women of the household. The attention attracted by properly located, well-arranged

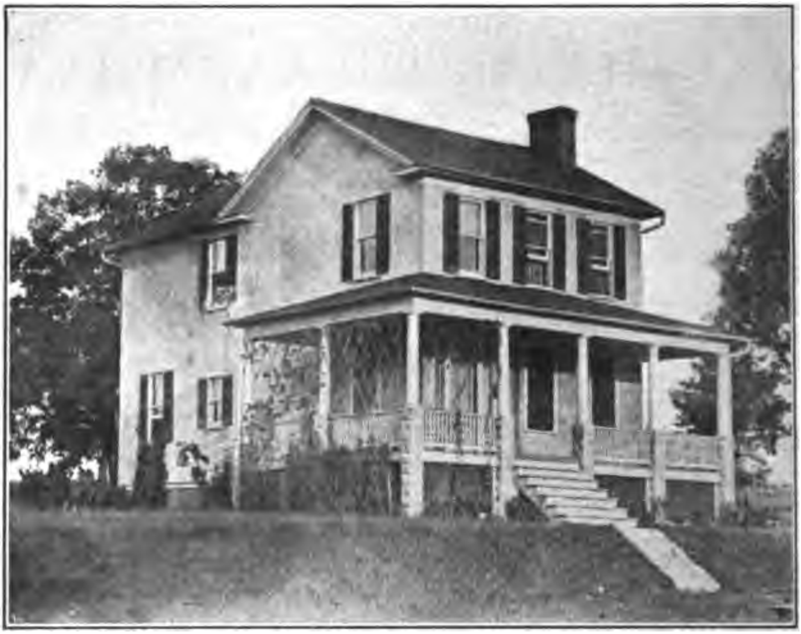

FIGURE 1.—A comfortable place to eat and sleep, but not all a home should be. Compare with Figure 2

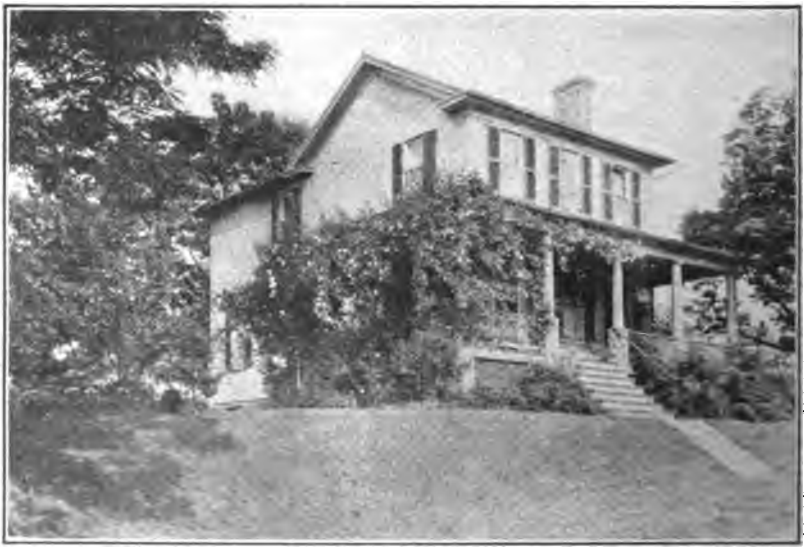

FIGURE 2.—The house shown in Figure 1 made homelike and attractive by plantings

buildings with good plantings is itself evidence of the extent to which these matters have been neglected in all parts of the country.

Among the opportunities of the farm family is that of beautifying the farmstead, so that it may be more attractive to the occupants. This, in turn, will tend to make both young and old more contented. It will also add materially to the enjoyment of those who pass and thus incidentally to the selling value of the farm.

Neglect of such improvement is usually due to one or more of the following causes: (1) A belief that any adequate improvement will be too expensive, (2) a conviction that it will require too much time and work for upkeep, and (3) indifference. The purpose of this bulletin is to suggest how unattractive conditions (fig. 1) about farmhouses may be made attractive (fig. 2) without undue labor or expense.

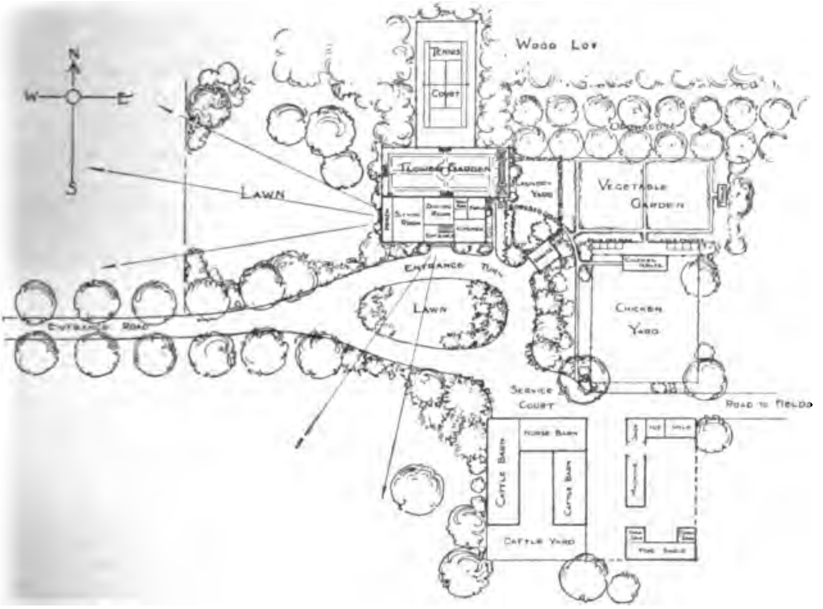

Figure 3.—A plan for a farmstead where the buildings are back from a north-and-south road

PLANNING FOR IMPROVEMENTS IN ADVANCE

A farmstead consists of the farm buildings and the land immediately surrounding them, not only the approaches from the highway, but also the cattle, hog, and chicken yards and the vegetable, fruit, and flower gardens. (Fig. 3.) Because of the intimate relationship between the farm home and the farm business, all these things must be taken into account when planning to improve the home surroundings, not only the house lot but the whole farmstead. Before any improvement can be made it is necessary to decide the working and living conditions that need to be met and the impression which it is desired that the home shall give.

The more carefully the plan is worked out, the less likelihood there is of unexpected difficulties arising as the work progresses. It is appropriate to include features that may not be carried out for several years, so these improvements can be made when the time comes without interfering with other features of the plan.

When an established place is to be improved it should be studied in the same way as a new place, forgetting all roads and structures except possibly the largest and most expensive buildings; even these should not be assumed to be incapable of being altered.

In planning a new place the first thing to be considered is the approximate location of the principal buildings, with the space they should have about them and the relation of that space and of the buildings to one another. Then the necessary drives and walks should be located, as well as all service features, such as work yards, laundry yard, and gardens. After this the detailed plans of the buildings should be worked out to conform to the general scheme, followed finally by the planting suggestions. To prevent difficulties it is necessary to plan the grounds carefully before the building plans are made and then make the building plans to suit. In this connection it is essential to study thoroughly the land conditions as to elevation, slopes, and drainage and also the desirability of the different points of the compass as exposures for the important rooms of the home or for facing the different buildings or the yards adjoining them.[1]

In addition, it is necessary to decide whether the development is to be simple and inexpensive or elaborate and pretentious, and whether the greatest possible economy of funds and land is essential or whether a liberal expenditure is permissible.

STYLE OF THE DESIGN

So far no distinctive type of American farm architecture has developed, although some localities have evolved characteristic styles. It may be expected that eventually many communities will develop their own styles especially suited to the local conditions. There are, however, two distinct types of landscape designs that are well recognized, the informal and the formal.

Informal design in landscapes (figs. 3, 4, 5, 6, 10, 11, and 12) in its purest form consists entirely of irregular curved lines. When straight lines or regular curves do appear they are united with architectural features, such as buildings, boundaries, steps, tennis courts, and formal gardens. Informal design is economical in development, as it usually can be made to conform closely to existing conditions, thus reducing grading to a minimum. It can be maintained with little work.

On the other hand, formal design in landscape (the flower gardens in figs. 3, 5, and 24 and the plan in fig. 9) is composed of geometrical figures, usually symmetrical,[2] and always balanced.[3] It is frequently emphasized by architectural or sculptural additions.

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[1] For further study of this phase of the subject consult the following publication, which shows a desirable arrangement for the same set of buildings when the desirable outlook faces each of the cardinal points of the compass: BETTS, M. C., and HUMPHRIES, W. R. PLANNING THE FARMSTEAD. U. S. Dept. Agr. Farmers' Bul. 1132, 24 p. illus. 1920.

[2] "Symmetry" in landscape design means that each part on one side of a central axis is exactly duplicated on the other. Each half of the design reflects the other half.

[3] "Balance" in landscape design means that the features on each side of an axis are of equal interest, but not necessarily alike. A symmetrical design is balanced, but a balanced design need not be symmetrical. The axis must be in the center of the interest, not necessarily in the center of the design. A large area of lawn with little planting on one side of a walk may be balanced, for example, by a smaller area on the other if it contains more striking objects.

In general, the more straight lines are used the greater is the formality. The buildings need to be regularly and symmetrically placed and appropriately designed. The ground must be graded to suit the plan. All the details both of grounds and of buildings must be carefully worked out to conform with one another, and the upkeep must be of the best continually. Formal design is inelastic, not readily permitting additions, and is relatively expensive in both installation and maintenance. A design may be symmetrical in all its parts or only in general outline while the details vary on the two sides of the axis.

In general, only informal designs are applicable to farmsteads except in limited garden areas.

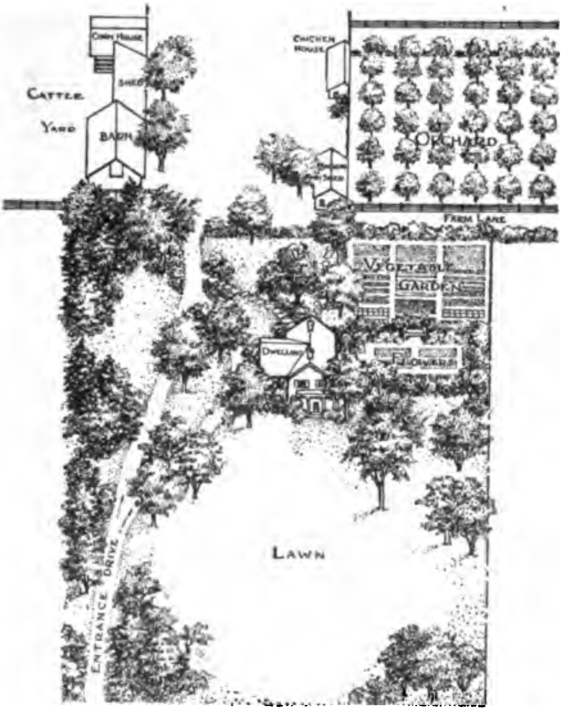

FIGURE 4.—Plan of a farmstead located near the highway

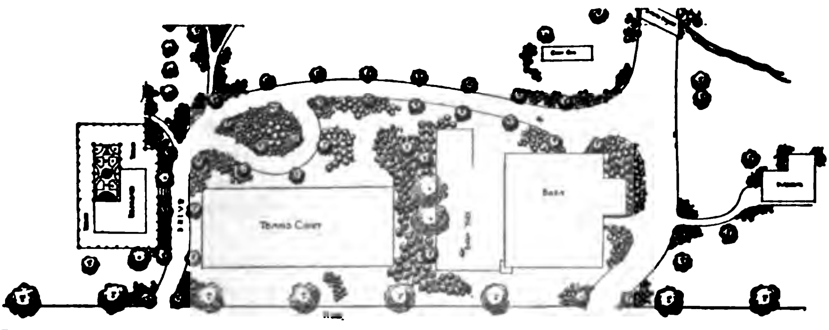

FIGURE 5.—A plan for a farmstead when a good house, barn, and tenant house were already erected close to the public road

Each plan is a study in itself, and only by considering the conditions to be met can a successful one be made. (Figs. 4 and 5.) The making of a good plan of the informal style is not difficult if the effort is made to meet existing conditions without attempting to do things simply for show.

The successful plan is one in which compromises are successfully made to give a livable, workable whole with an appearance of modest comfort. On most farms this work can well be done by the farmer and his family. For expensive places or for places where much grading is involved, the employment of a landscape designer is usually more satisfactory and economical.

If the plan is good, much can be accomplished in the way of improved appearance with only a little work for installation and maintenance. If too much ground is included in the farmstead or if the design is made too intricate, the care of the premises will be burdensome. A little ground neatly kept is more attractive than more ground not well maintained. On a small farm 2 acres can often be made to accommodate the buildings, with fruit and vegetable gardens adequate for a small family (fig. 6), while on larger places 10 acres or more may not be inappropriate. The more pretentious the buildings, the more ground is required to give a proper setting. Cramped grounds dwarf the effect. Too much ground is undesirable, because the care required is out of proportion to the needs.

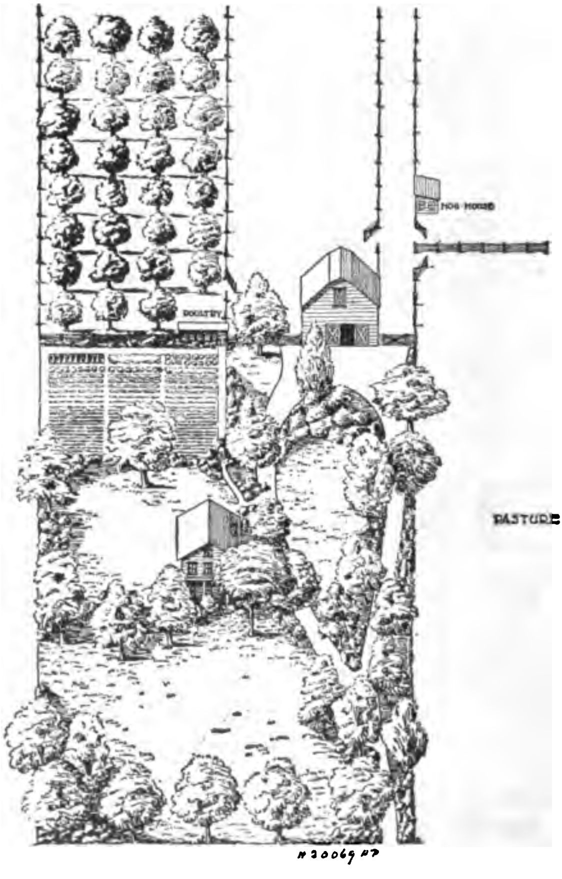

FIGURE 6.—Plan of a 2-acre farmstead

The essentials of a good design for a home are that the buildings and grounds shall be comfortable, convenient, appropriate, and attractive. The first three conditions should be solved with the fourth constantly in mind so that all will be worked out together.

If a formal flower garden (figs. 3, 4, and 24) or other features that require special attention in maintenance are desired, the grounds should be so planned that these may be added after the other portions are developed and the amount of care necessary to maintain the developed portions has been determined from experience. In this way, features calling for special maintenance will not be added until sufficient labor is known to be available to care for them properly.

The personal tastes of the members of the family should determine very largely the extent and character of the development.

LOCATION OF THE BUILDINGS

The factors that should determine the location of buildings are (1) access to a good highway, (2) possibility of protection from objectionable winds or the utilization of desirable ones, (3) practicability of adequate drainage, (4) a sufficient supply of good water, and (5) desirability of outlook.

The construction of hard-surface roads in the open country is making it possible to get to and from town at all times of the year. This is important for both business and pleasure. The exposure is an important consideration for securing the comfort of the family and stock. In cold countries protection from the winter winds is desirable, and the location of the most used rooms should be on the warmest side of the house, while in warm countries the house and living rooms need to be so located as to get the benefit of prevailing winds during the hottest months.

If at all possible, the house should be so located near good trees that their shade may be used and enjoyed by the family every day during the summer. It takes so long to grow good trees that existing trees should be cherished and utilized to the fullest extent.

The elevation should be such as to make possible thorough drainage, even though it may be desirable to keep off the highest ground. Under no circumstances should the house get the drainage from other buildings.

In a hilly or mountainous country the site should provide a little level land immediately adjoining the buildings, especially the dwelling. This is necessary both for appearance and for comfort in living. Where such a setting is not provided the house is likely to give the impression of being about to slide from its location, while with a little level ground close by, it may give the appearance of fitting closely into the site. In the case of a side hill or bank house it may be necessary to build with one side facing on a higher level than the other. If the level areas are of reasonable extent, although at different heights and separated from each other, the desired impression may still be given.

The rooms used most should be given the benefit of the best views; those from the kitchen as well as from the living room should be attractive. The near view should be over an unbroken lawn, and there should be some object of interest beyond. If there are no such objects in the general landscape, such as a mountain, a water view, a woodland, a meadow, or an extended farm view, a handsome tree or other bit of near-by landscape may be available. Lacking these possibly some feature may be created on the place, such as an attractive group of shrubs, well placed and arranged so as to have something of interest each month.

The area that should be set aside for the house lot is dependent on many factors. The larger and more pretentious the house the more land should appear to be with it. Though it may be necessary to have a lawn that is small, it is frequently possible to increase the apparent size by making adjacent areas appear to belong with it.

If the apparent size can not be increased, as suggested under "Lawns," it should be at least possible to prevent the dwarfing of the appearance by growing only low crops in the near-by fields, keeping tall crops and orchards at a little distance. Where this is impracticable the area of the home lot should be doubled or trebled.

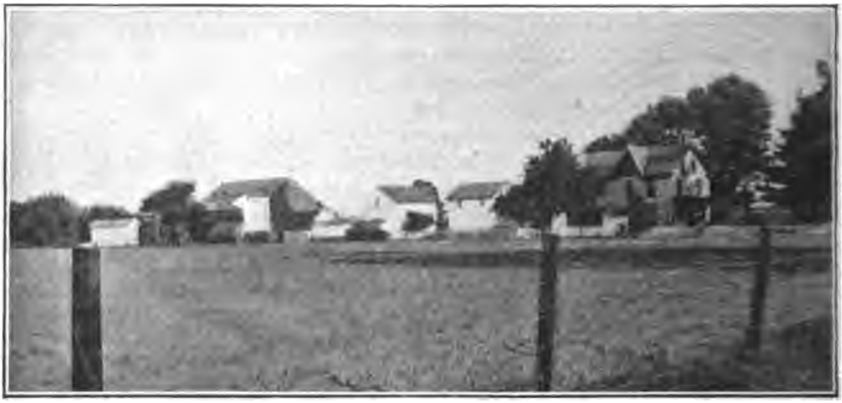

FIGURE 7.—A farmstead having too many unrelated buildings

The barns should be properly arranged to facilitate the farm work and be accessible to the road, but they must also be reasonably convenient to the house without being too close, prominent, or obtrusive. They should be so situated with respect to the house that the prevailing winds, especially during those seasons when the doors and windows are likely to be open, do not blow from the barns

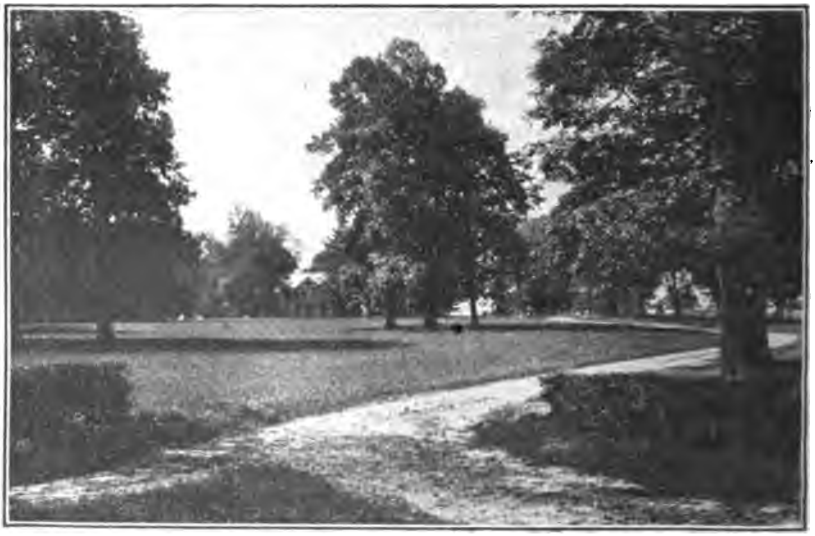

FIGURE 8.—A direct-approach road that appears to lead primarily to the house through an appropriate entrance. It leaves the lawn unbroken in front of the house, thus giving a desirable setting for it

toward the house. On the other hand, in cold climates the barn as well as the house needs protection from severe winter winds.

Further, the buildings must be arranged for convenience. The interior of the house and its connection with the outside features, whether the barns or the public road, should be adapted to the everyday life of the family. All too common examples of inappropriate farm architecture are front doors that are never used except for funerals, and parlors that are so seldom used that when they are they cast a reserve over the whole family. Drives and walks to such front doors are a meaningless formality and should be eliminated. In a house of such design the neighbors usually go directly to the kitchen, because they know that is the entrance the family uses, and the life of the family is so far from the front door that it is impossible to get any response even if the attempt is made. A more pleasing and satisfactory arrangement is to have the entrance open directly on the part of the house the family uses. (Figs. 3 and 4.)

The entrance should be so located as to be easy and natural for both family and visitors to use. The approaches to it should be so direct that there is no feeling of being taken out of the way in following the roads or walks provided. In such an arrangement the entrance and approaches are naturally used in accordance with their design.

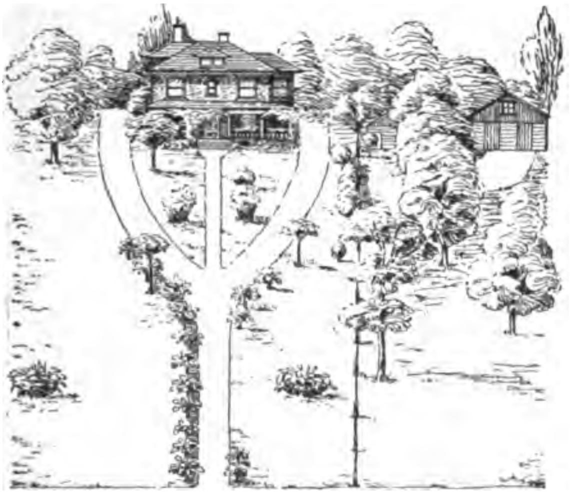

FIGURE 9.—Undesirable arrangement of an approach to a farmstead. Compare with Figure 10

The barns should be at a little distance from the house, but close enough to facilitate the work to be done, and of such a character architecturally that they look as though they belonged together. The buildings should be as few in number as is practicable, or at least should have the appearance of being a unified group from the principal viewpoints. Such results can be brought about by careful grouping, sometimes even building them around a courtyard, or if necessary connecting some of them by sheds or walls. The objection to close grouping is the danger from fire, but facility in doing the work may be an offset to this. A number of small unrelated buildings gives a "cluttered up" appearance. (Fig. 7.)

WALKS AND DRIVES

The entrance to the farmstead from the public road should be so located as to facilitate direct and easy access to both house and barn and make the approach to either seem natural and easy, while at the same time appearing to lead primarily to the house. (Fig. 8.) It should be direct, but as a rule not straight toward any of the buildings. (Fig. 9.) Where the buildings are near the highway, a good plan is to have a single road enter the grounds, then divide, one branch going directly to the barn and the other past the side of the house, passing near the main-entrance door (fig. 10), thence near the kitchen entrance, rejoining the road to the barn in such a way that the traffic may conveniently pass to the barn or return to the highway (figs. 4, 6, 11, and 12). This arrangement of a double road is to permit traffic to reach the barn without passing close to the house, while not greatly increasing the extent of road surface. The approaches should be so curved as to permit plantings partially to hide the barns and service yards. In hilly countries the lay of the land will largely determine what may be done, and it correspondingly gives opportunities for variety of treatment.

In flat countries the problem of providing an approach is not so difficult, but it requires thought and care to have it convenient without being commonplace and uninteresting.

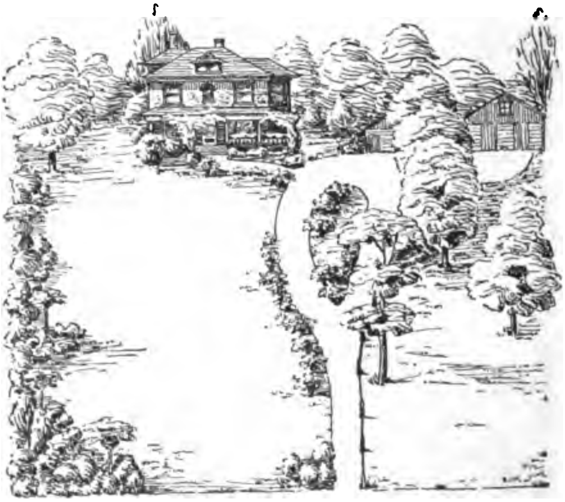

FIGURE 10.—A revised design for an approach to the farmstead shown in Figure 9

Where the buildings are located far from the highway, an approach from the public road to the group of buildings become necessary. In hilly countries this will often need to be curved in order to avoid objectionable grades. As far as possible the road surface should be kept hidden from the home, but on approaching, the visitor should, from time to time, get glimpses of the house and should feel that he is going toward it, although not straight at it. In a flat country, especially where the farms are all laid out in rectangles, the approach from the highway should be straight till it reaches the farmstead (fig. 12) when the same general scheme may be adopted as though the farmstead were located directly on the highway.

A long straight approach road is made more effective by a row of trees on each side (fig. 13) forming a vista under their tops. There should be some attractive object to which the eye is drawn at the end of the vista, such as a beautiful tree or a clump of shrubbery. It is seldom desirable to have a door as the focal point, but where one is used it should be an entrance door, not the door that leads to the lawns and pleasure grounds of the family, as the latter should have more

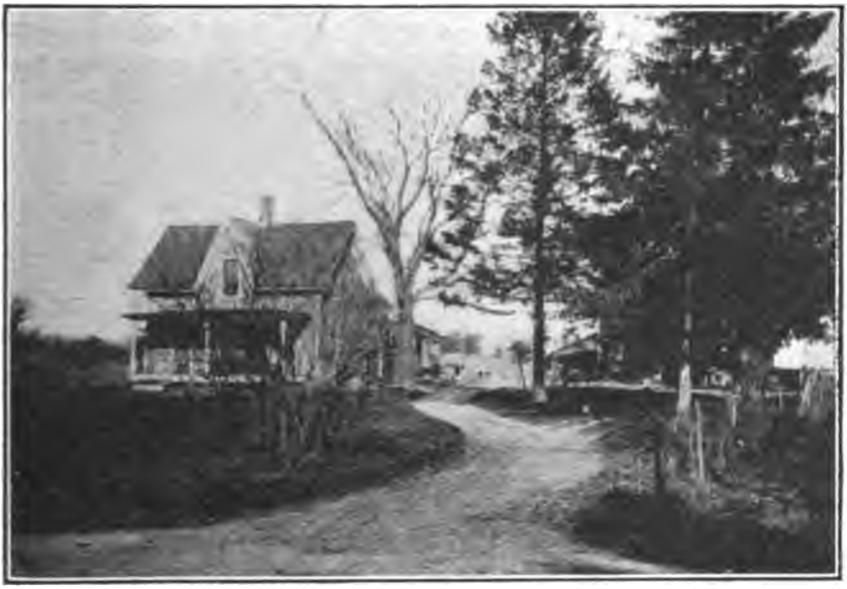

FIGURE 11.—A good approach for buildings near the highway

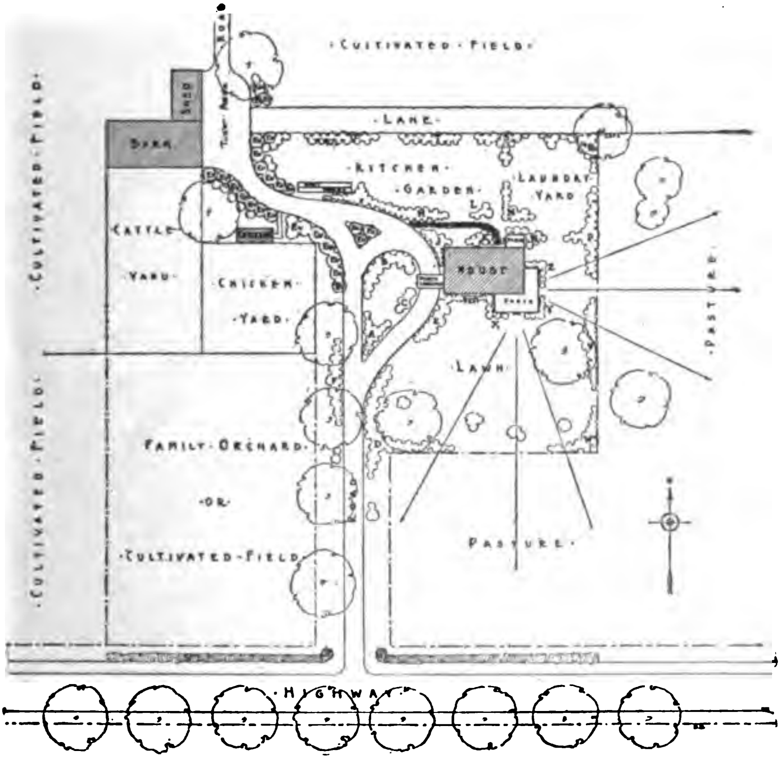

FIGURE 12.—A good entrance to buildings located well back from the highway

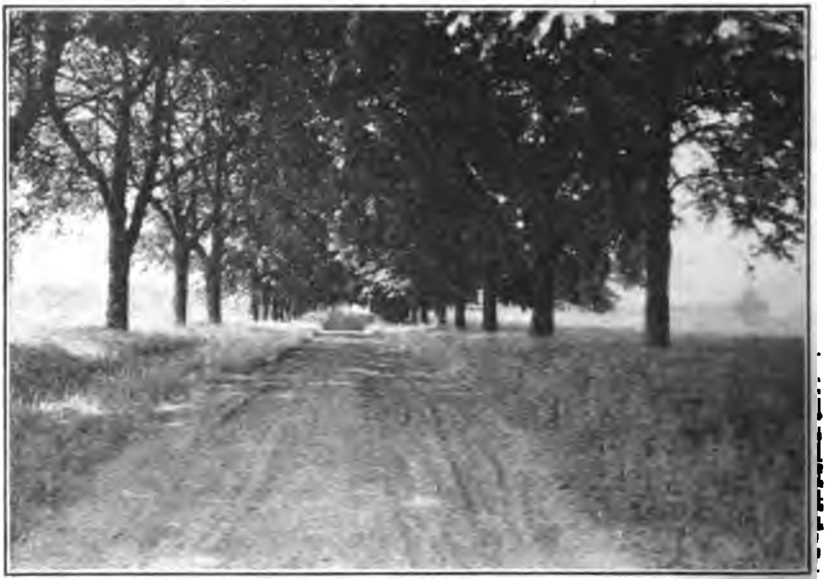

FIGURE 13.—A long straight approach made attractive by a row of trees on each [illegible]

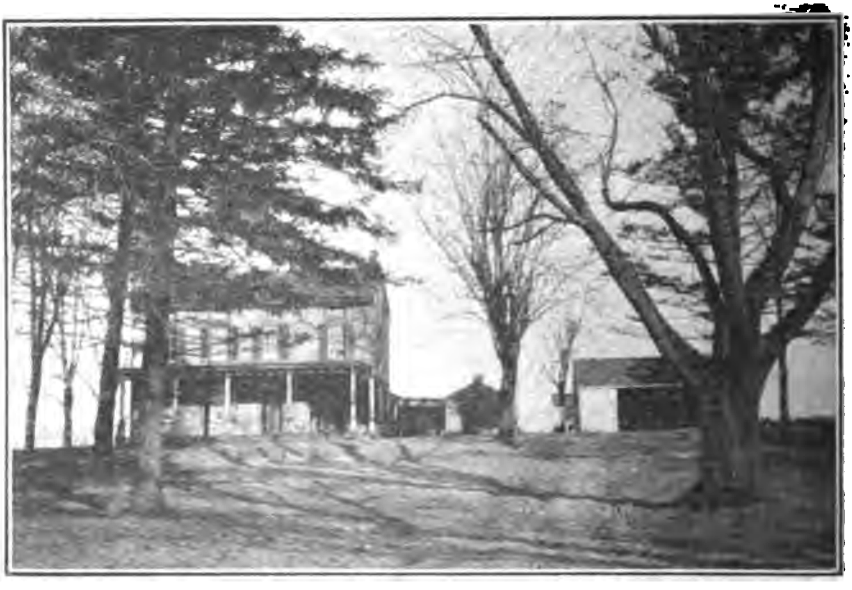

FIGURE 14.—An inappropriate approach to a farmhouse. The opening to the woodshed could easily be screened by a careful planting of evergreens

privacy than could be given a door fully exposed to view from the main approach. Also when a doorway is used the driveway should swing away from the direct approach before it comes too close. On the other hand, ugly or uninteresting objects should not be the terminus of such a vista. (Fig. 14.)

The other walks and roads about the farmstead should be as few as possible. All real needs should be met, but no provision should be made for fancied or possible ones. If in doubt, leave out a walk until experience shows the need of it.

All roads and walks should be so located as to give the feeling of leading to their destination without unnecessary turns. This does not mean that they must be straight. They might be slightly curved and yet give the impression of leading to the desired end. Where the distance is not too short a curved walk or drive usually gives a more pleasing effect than a straight one. The amount of curve need not be great; often a deviation of the width of a walk or drive (fig. 15) will answer, while one and one-half times its width will be ample. On the other hand, curves should not be too abrupt, and there should appear to be a reason for each. Appropriate plantings can often be made to supply this reason, and they are always useful in supplementing other reasons. In a rolling or hilly country the slope of the land can usually be made to give an excuse for the curves.

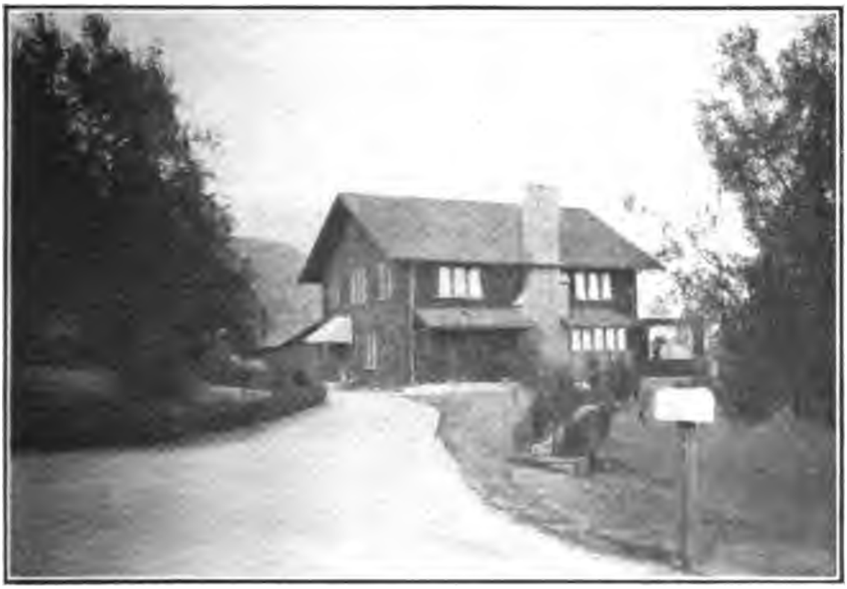

FIGURE 15.—A satisfying result with a slightly curved roadway, a deviation of not more than its own width

Paths and roads should be kept as nearly out of sight as is feasible. Where practicable to conceal them by construction behind knolls or through depressions, this should be done if it does not interfere too seriously with their directness and if good drainage can be provided. Plantings of trees or shrubs may also be used. (Fig. 16.) Paths should not be installed where established roads can be utilized, even though it may take extra care and expense to keep the road surface in condition for the dual purpose of walk and drive. If it should not be practicable to keep the road in good condition for foot traffic, of course a separate footway would need to be developed, but it should be omitted unless really necessary. From the standpoint of both appearance and expense of upkeep, the fewest possible drives and walks should be provided. A little-used walk or drive is usually as troublesome and as expensive to keep up as a much-used one, as it will grow full of weeds and will wash whether used or not.

The entrance from the highway should largely reflect and suggest the character of the farmstead. The less formality there is in the farmstead the less there should be at the entrance. Some special treatment is necessary, however, to attract attention to it and set it apart from the rest of the boundary and to invite entrance, at least to the extent of inciting the wish to enter in those who pass. The character of this special treatment must so nearly correspond with the rest of the treatment of the farmstead that it can be united with it without an abrupt change of style at any point. The transition from a heavy stone or brick post to a barbed-wire fence is difficult unless the size of the farmstead is such that there is sufficient distance to make the transition gradually. If the post is flanked by a wall of the same material that ultimately becomes the same height as the fence, and the fence and wall are covered with vines for a considerable distance on each side of the joining, a successful transition can be accomplished. Such a wall, however, is inappropriate unless built of native stone in evidence in fences or buildings in the neighborhood or else like the stone or brick clearly evident in some portion of the buildings.

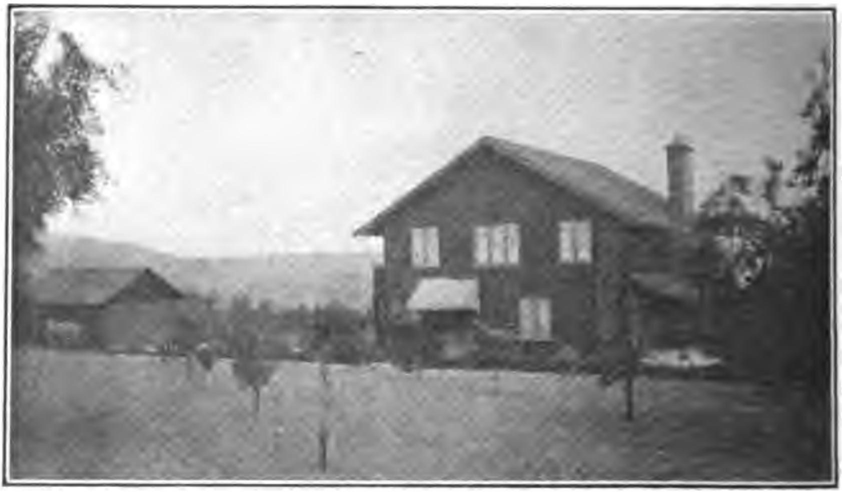

FIGURE 16.—A well-hidden approach and service road. See Figure 15 for another view of the same road

The design of the wall also has an important bearing on its appropriateness. The wall of native stone in Figure 17 is appropriate and attractive. Figure 18 also shows a good entrance for its location, but

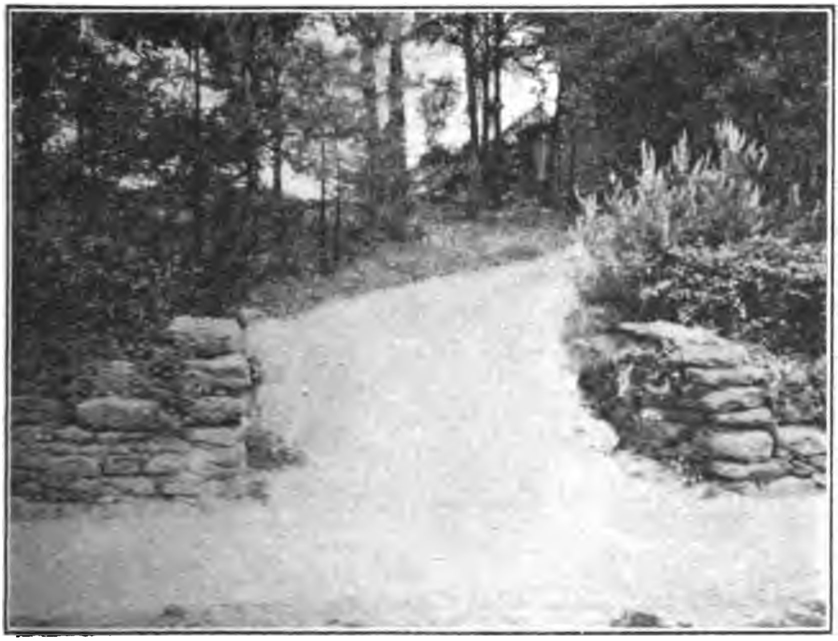

FIGURE 17.—A well-designed entrance. The appearance of the stone wall has been improved by recessing the cement joints

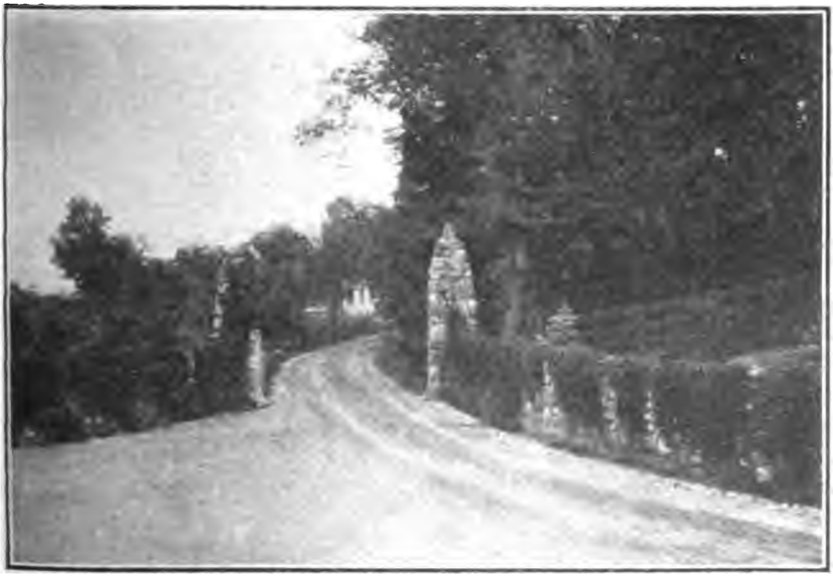

FIGURE 18.—A good gateway and wall for the location. Were it not for the mass of foliage behind, the posts would be too tall and too heavy

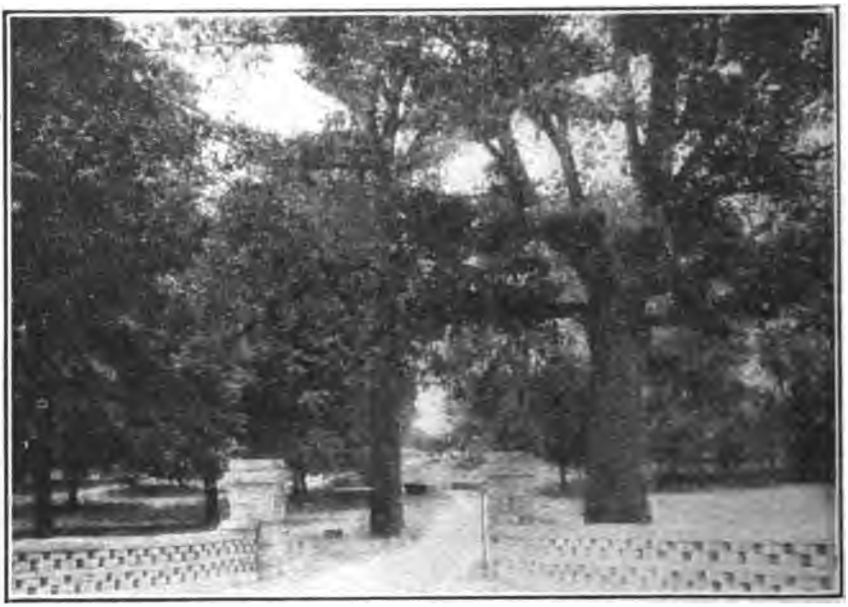

FIGURE 19.—A wall suited only to a formal landscape

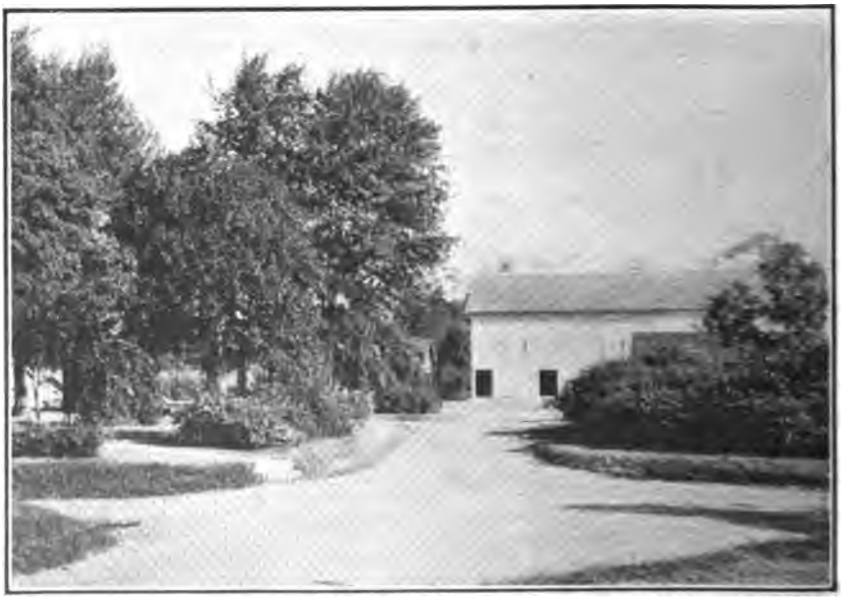

FIGURE 20.—Informal plantings at the entrance to a farmstead

one that would be most inappropriate were it not for the heavy background of trees. The wall is good and is well covered with vines. The posts would be too heavy as well as too tall in most situations. The wall in Figure 19 is so formal that it should be used only with a formal landscape, and then only when the buildings are of a similar checkered design.

Plants can be much more easily arranged to emphasize an entrance without overdoing it than can architectural features. Entrance plantings may either be formal, such as hedges (fig. 8) or regularly placed specimens or clumps, or they may be altogether informal and irregular (fig. 20).

As with all other details of the farmstead, development at the entrance, whether primarily of plants or of other material, must be appropriate in size, shape, and kind. Especially with plants there is a wide latitude of possibilities that may be appropriate, but the limits must not be exceeded if a fitting result is to be obtained.

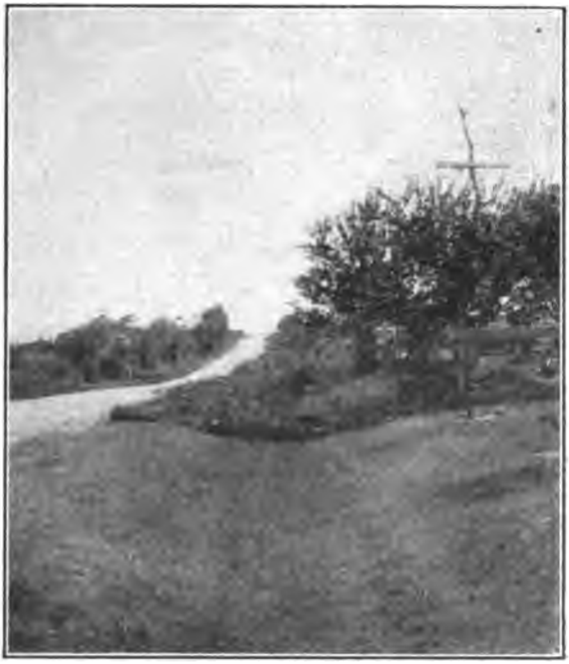

FIGURE 21.—A turf gutter

As a rule, farm roads will be made of the natural soil and should be well crowned and provided with good gutters with liberal outlets. In most parts of the United States little-used roads and many paths, even though much used, can be covered with turf and mowed, like the lawn. If the road is used sufficiently to cause ruts, soil can be brought to fill them. Where a more resistant surface is needed for a short time each season, stones 2 inches in size or larger may be mixed with good soil, and 6 or 8 inches of the surface of the road may be formed of that material. Grass will grow in the soil, and the stones will not permit a cutting up of the roadbed or the permanent destruction of the grass. The grass tops may be worn off by the traffic, but the roots will push out again after the wear ceases. Turf gutters (fig. 21) may be found satisfactory for road and walk drainage in all sections where there is sufficient moisture to maintain turf growth. To be successful, no ridge or shoulder should be permitted between the turf and the road. Some material always collects in the gutter, gradually raising it, so that every few years it is desirable to lift the sod, remove some of the dirt under it, and relay it. Although this may seem like a good deal of a job, it will probably have to be done so infrequently as to prove one of the most economical ways of maintaining a gutter.

Where an artificial road surface is needed, it should be as inconspicuous in color as possible. Cinders are one of the most desirable private-road surfacings, both on account of the color and because of good road-making qualities. Oyster shells, crushed limestone, concrete, and light-colored brick each have an objectionable color, contrasting too strongly with the normal green of country surroundings. Stone with dark asphaltic oil or concrete colored by lampblack is pleasing in appearance.

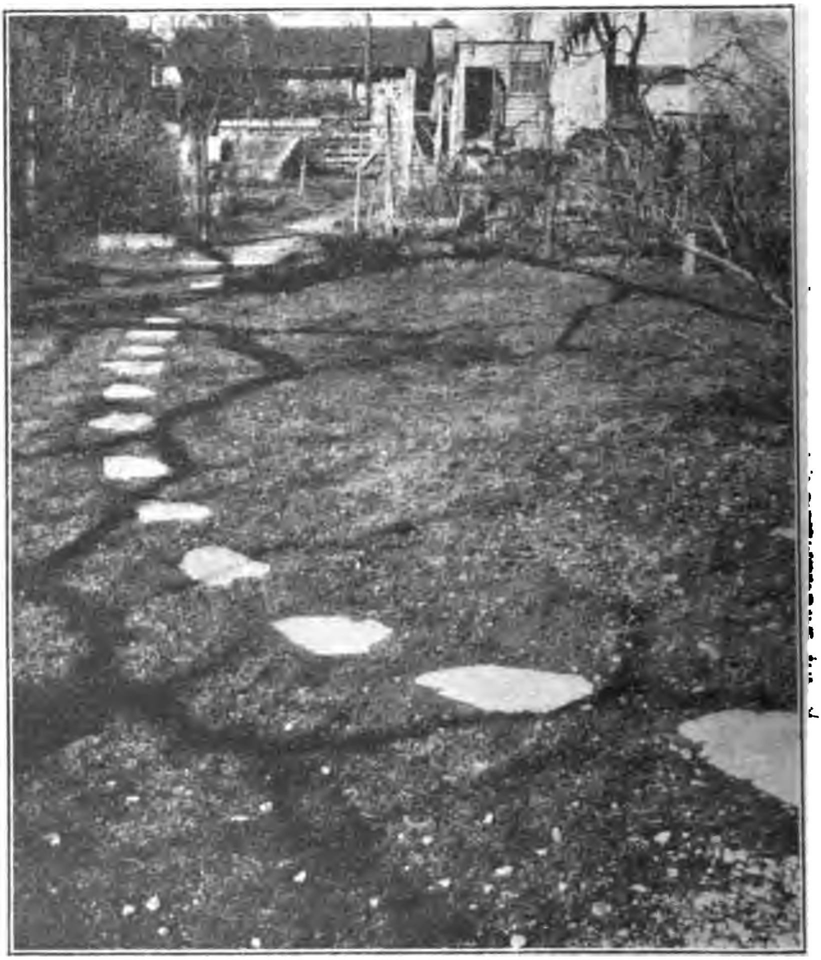

FIGURE 22.—A stepping-stone walk

Turf does not make a good surfacing for footways that are much used in wet weather, especially if used when frost is coming out of the ground. For such conditions nothing is more attractive than flat stones placed in the turf with the grass growing between them (fig. 22), but they need to be set low enough to permit the lawn mower to pass over them. If, however, a cement walk is necessary, a dark color should be given it by the free use of lampblack, while crushed-stone walks can be held together and be more suitably colored by using some asphalt or coal-tar preparation.

SERVICE FEATURES

Provision must be made for features that facilitate the work of the farm or increase the comfort of living. These include such things as work yards, storage yards, and cattle yards about the barns, an ice house or a place for a mechanical refrigerator, fuel storage, and laundry yard near the house. Fruit, vegetable, and flower gardens should also be provided. Such features may be so arranged as to serve the needs without being unduly conspicuous. One feature frequently overlooked is provision for the delivery of the fuel supply near the place where it is to be used from roads arranged for other purposes. Failure to provide this is a continual cause of vexation.

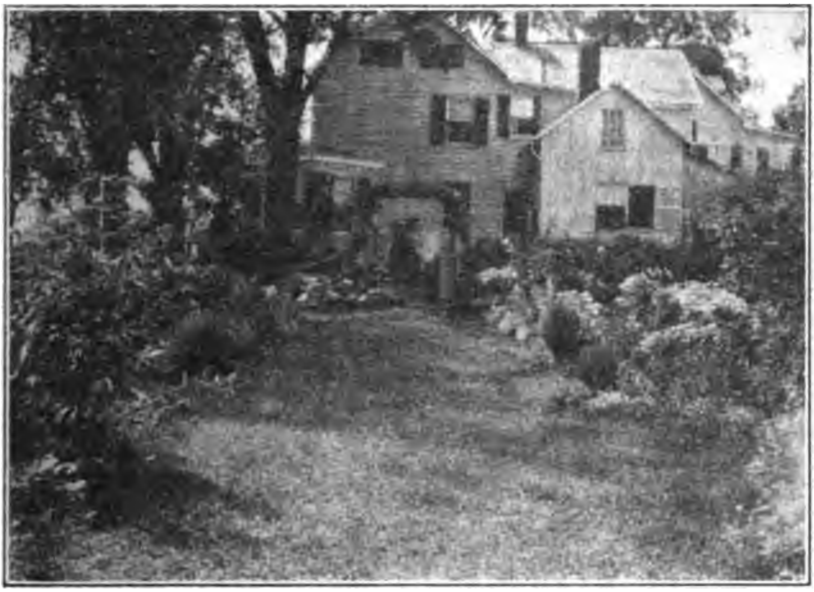

Figure 23.—A combined vegetable and flower garden convenient to the home. This turf walk is used as the turning space for the cultivator which runs between the rows laid out at right angles to this turf entrance way

Wherever possible, buildings for several purposes should be united or be so located as to appear as one rather than multiply the number of buildings, as a large number of small apparently unrelated buildings detracts greatly from the appearance.

The fruit and vegetable gardens for growing cut flowers for indoor decoration, as well as the ornamental flower garden, are part of the farmstead and should be used in its setting. They will be pleasing in appearance if properly placed, well laid out, well cultivated, and kept neat. They should be located so they are convenient to the house (fig. 23), but usually not between the house and the road or at any other point where they will detract from the view of the farmhouse from the highway. A partial hiding of them by ornamental plantings may often so reduce their conspicuousness in an otherwise undesirable place as to make them a pleasing part of the picture. They should be arranged so that they can be efficiently cultivated, preferably by horsepower, as two essentials of an attractive farmstead are neatness and the evidence of cultural success. The accomplishment of these should be made as easy as practicable without unduly sacrificing the decorative possibilities. The more ornamental the garden is designed to be, the greater the care required in its culture and maintenance. The careful placing and arranging of fruit and vegetable gardens, however, should not be made an excuse for omitting a flower garden, even though it has to be a small one. Occasionally it may be combined with the vegetable or the fruit garden.

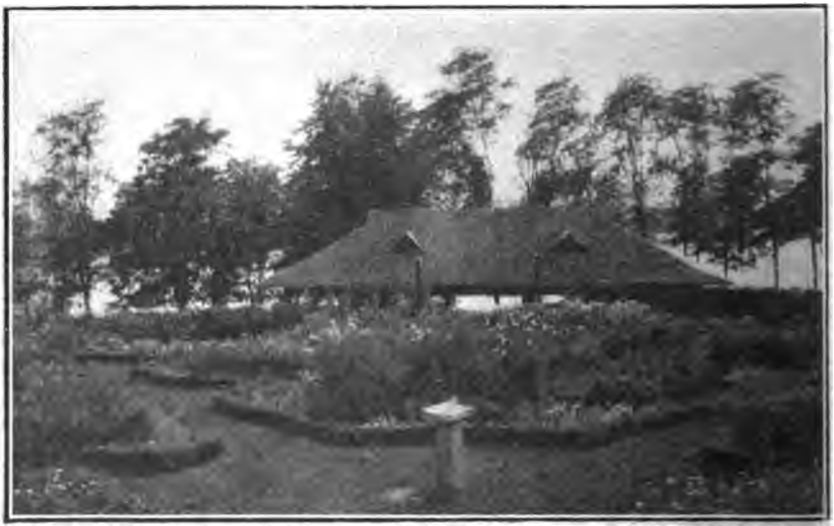

FIGURE 24.—A formal flower garden with informal plantings.

An ornamental garden, whether devoted to flowers, vegetables, or fruits, is in the nature of a transition from the formalities of the house to the informalities of the lawns. Its purpose and use should be largely that of an outdoor room. It may be either formal (fig. 24) or informal, but in either case it should be regarded as part of the house and its activities, not as its principal setting. It comes closer into the family life if it is on the side of the house away from the public entrance and near to the living porch, so that it is easily entered from the porch. It should be included whenever the family tastes and circumstances permit the expenditure of the extra labor involved.

Such a garden may be simple, involving little work, or it may be elaborate. It should be the most definite expression of the family tastes. A place for such a garden should be provided on the plan, but it may be left in lawn until the time comes for its development.

Probably the greatest enjoyment of such a garden comes in its gradual making. Within the shrubbery borders, walks, arbors, seats, a summer house, or a pool may be incorporated. Here personal taste may find free expression with less restraint from surrounding conditions than in any other part of the grounds.

Flowers about the house are to beautify the grounds; therefore to depend on such flowers for cutting is to defeat the purpose for which they are intended. Although flowers may at times be cut from general plantings or from an ornamental flower garden without injury or detriment, yet such plantings should not be regarded as the legitimate source of cut flowers nor should cuttings be permitted to such an extent as to mar the appearance of the plantings as a whole. Most of the flowers for cutting for indoor decoration should be grown especially for that purpose, either in rows in the vegetable garden, where they can be cultivated by horse tools, or in their own garden, which also should be arranged for economical cultivation.

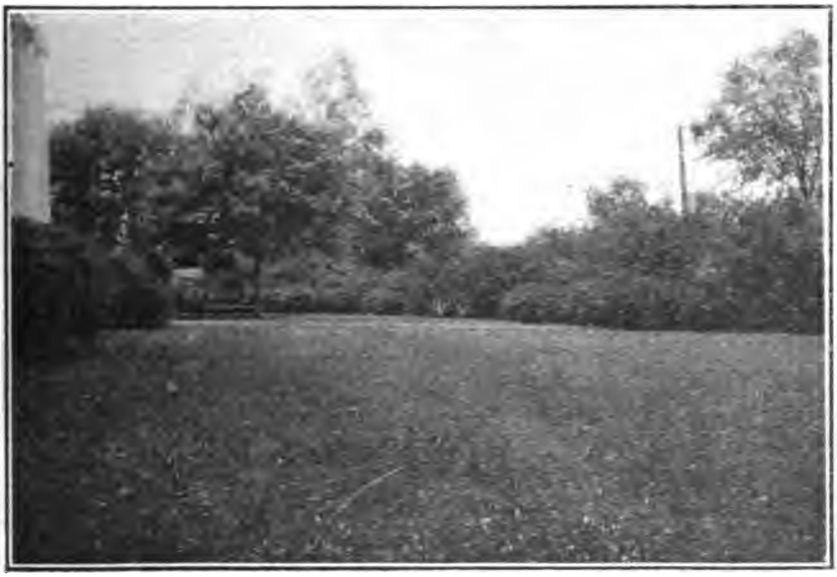

FIGURE 25.—A lawn with irregular outlines

LAWNS

Lawns are the background or foundation against which all the details are viewed. They should be in as large and unbroken stretches as possible, as this produces a pleasing effect, tending to give an impression of great extent and also making them easier to maintain. The borders should be irregular (fig. 25), for an irregular outline increases the apparent size of the grounds by not revealing at one glance their actual limits, the depth of all the bays are not visible from any point, curiosity is aroused as to what may be in the hidden places, and thus the grounds are made more interesting.

The surface of the lawn should be smooth enough to permit the easy running of the lawn mower, but many of the natural undulations should be kept, and if the surface is inclined to be flat some effort might be expended to increase them slightly. Steep banks are objectionable, as they are more difficult to maintain than moderate slopes. Wherever it is necessary to have changes in grade, an effort should be made to accomplish it in the most natural manner practicable. If at all possible this should be by using a double curve, known to carpenters and landscape designers as an "ogee," which consists of a convex surface for the upper part of the slope and a concave surface for the lower part. Such curves may be either short and sharp (fig. 26) or long and flat (fig. 27).

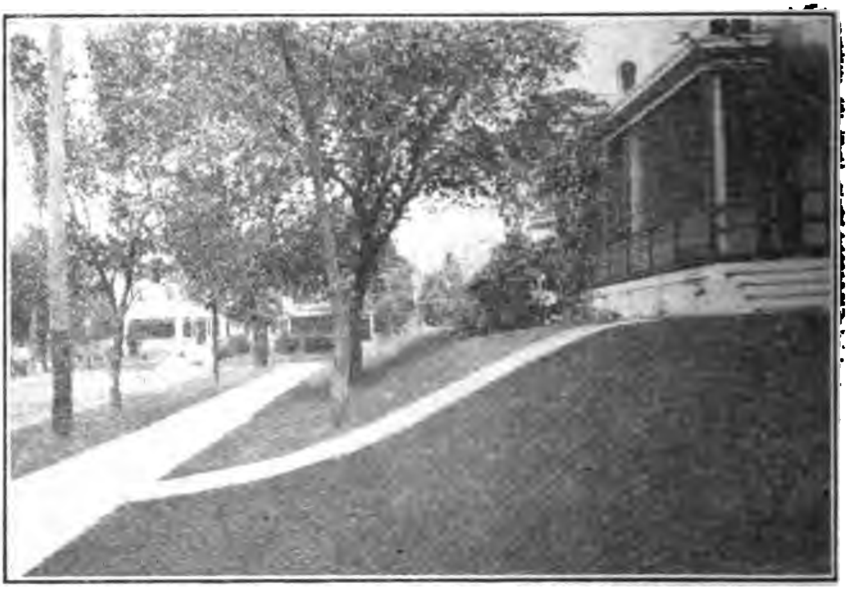

FIGURE 26.—A sharp ogee. There should be no line between the convex curve at the top and the concave one at the bottom; they should merge one into the other

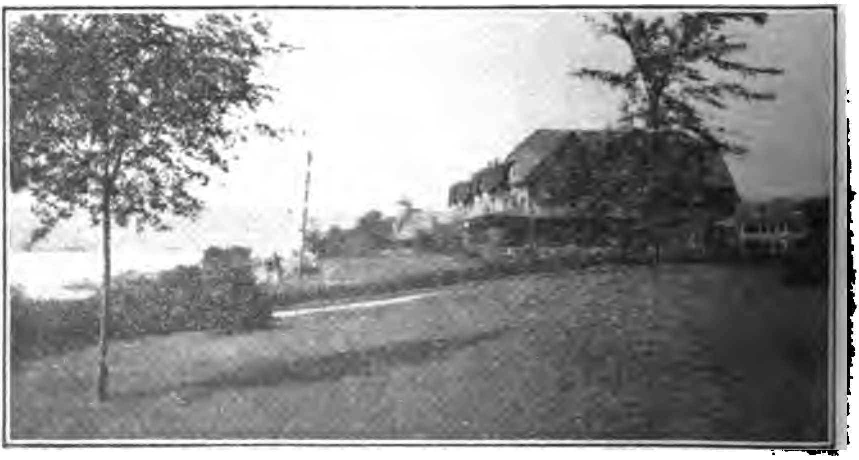

FIGURE 27.—A long ogee

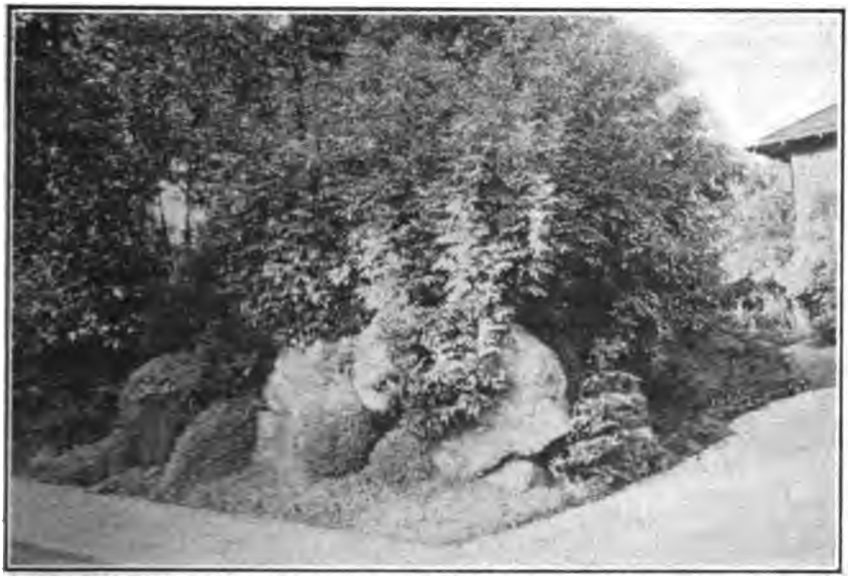

FIGURE 28.—A bank held by rocks

Where banks similar to those on railroad cuts or fills are necessary they should be held in place by embedding rocks in the surface (fig. 28) when stone is available, and planting among the stones, or by setting out shrubs or vigorous vines (fig. 29).

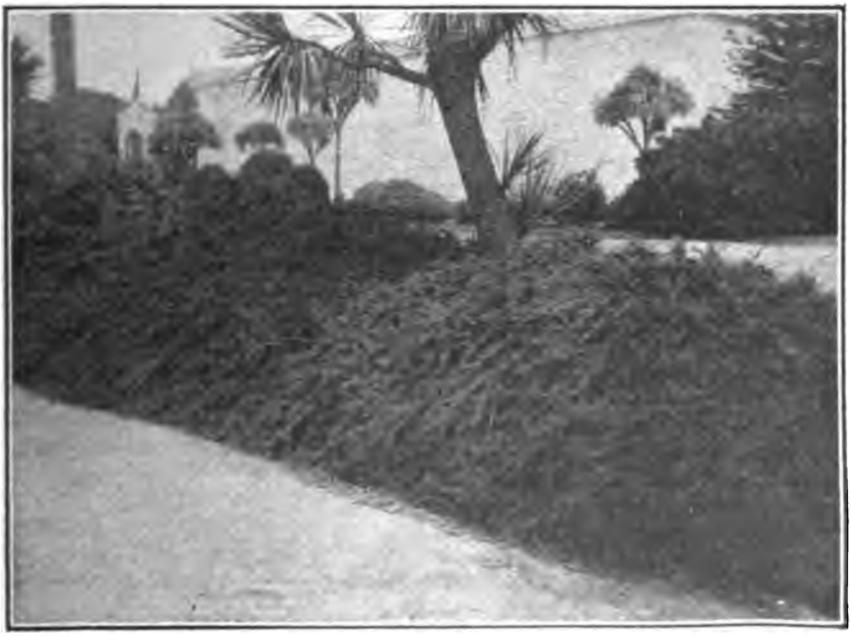

FIGURE 29.—A bank held by vines

Plane surfaces, either flat like a table or on a slope like a roof, are not desirable except in formal gardening.

The best lawn cover for the region should be used, even if it requires a little more care to establish it. In most parts of the United States this is grass. In a few places other ground covers must be used unless great care can be given the lawn.

Lawns should be of sufficient size to give an ample setting, especially for the house. If well placed, 2,000 or 3,000 square feet may answer all purposes, although much more space is better. The apparent size of a lawn may often be materially increased by having a pasture adjoining it and separated by the most inconspicuous fence possible, located in the least obtrusive position. (Fig. 30.) By care in scattering manure from time to time in order to prevent the grass from growing in clumps, and by cutting weeds or grasses that tend to grow in bunches, such a pasture may be made a very attractive extension of the lawn, especially if it is provided with a few clumps of fine trees.

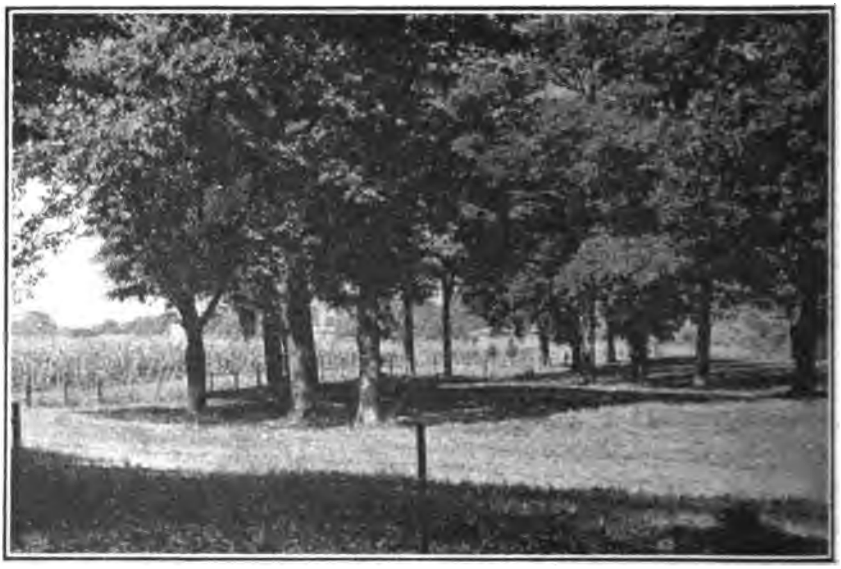

FIGURE 30.—A pasture as an extension of a lawn

If the surface of the lawn is made reasonably smooth and it has been graded so that there are no steep banks, keeping the grass cut should be a comparatively easy matter. The finest turf is obtained by cutting with a lawn mower every 5 to 10 days, depending on the season. A small area can be cut with a hand mower or a larger one with a horse-drawn mower. If the time necessary to keep a turf smoothly shaven is felt to be greater than is justifiable, an ordinary field mowing machine may be used from once in two weeks to two or three times in a season.

If cut every two weeks, it may be possible to permit all clippings to remain on the ground. If cut less frequently the clippings will probably have to be removed after each mowing. Animals should not be turned on the lawn to graze, as they will be likely to eat and trample the shrubbery as well as the grass. It is best to make a clear distinction between a lawn and a pasture extension.

ARRANGEMENT OF PLANTINGS

Although the discussion of planting is left until last, it is not because it is of least importance in the development of an attractive farmstead but rather to make more clear its true function. There is a widespread lack of appreciation of the importance of the matters already discussed, and a corresponding feeling that no matter how poorly arranged and designed a place may be it can be made beautiful by a few flower beds properly located. This idea of the power of plants to beautify is not entirely erroneous, but it is certainly exaggerated. Although they can greatly soften grave faults, they can not hide them. While even a well-designed farmstead is bare and unattractive (fig. 1) until properly united by plantings of trees, shrubs, and flowers (fig. 2), on the other hand plants may be so poorly arranged that they fail to add as much to the appearance as they might.

Plant arrangement as well as design of the grounds may be either formal or informal. Formal planting is the arrangement of plants in regular order, either in straight lines or in balanced geometrical designs. This is true whether the effect is produced from the regular placing of individual plants or by massing several specimens of a kind. Such planting is appropriate only in a formal design, which on farmsteads would be in connection with long straight approaches or in formal gardens.

Informal planting is the arrangement of plants irregularly, more or less in the manner in which they are found in native woodlands and thickets, and they may be used singly or in groups of any size with any number of kinds. Planting of this kind is appropriate with either a formal or an informal design and is especially adapted to farmsteads and home grounds.

In formal plantings all the plants must be set and trained to conform to the design (figs. 6 and 24), while informal plantings should be placed irregularly and trained to bring out the individual characteristics of each variety, so that the result may be as varied, graceful, and natural as possible.

TREES

Trees are of great importance in giving an attractive appearance to the farmstead as well as in making it a more comfortable place in which to live. They should be planted with the possibilities of this twofold use clearly in mind. In most of the country north of the fortieth parallel there is need of protection from the cold northwest winds of winter and also of shade about the buildings in summer. To meet the former requirement, groups or clumps of trees should be so located that they break the force of these objectionable winter winds, while at the same time they occupy the least possible area of tillable land.[4] In hilly regions many farm buildings are built in the lee of a rise of ground or close against the side of a hill, so that there is less need of shelter planting. Such plantings are more effective if made largely of evergreen trees, especially those which normally hold their lower limbs. Where shelter is needed it should be so located with respect to the buildings that the trees will not only give the needed protection but also form a background or setting for the buildings from as many points as possible. In addition to the trees providing the shelter, smaller flowering trees can be used in front to give an added interest. In other large areas, particularly in the western part of the country, where protection is needed from drying southwest winds, a similar use can be made of shelter plantings.

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[4] Information on shelter-belt planting is found in the following publication: WILSON, R., PLANTING AND CARE OF SHELTER BELTS ON THE NORTHERN GREAT PLAINS. U. S. Dept. Agr. Farmers' Bul. 1603, 13 p., illus. 1929. [In press.]

Shade trees should be located having in mind first their value as a setting for the building and then the desirable points at which to provide shade, as they will give shade wherever they are set, but will make a good setting only when properly placed. A sufficient number of trees should be used, however, to make enough shade to invite to outdoor life near the house. They should not be planted directly in front but should be placed somewhat to each side so as to make a frame through which a view of a portion of the front is obtained, and so that when they are grown they partially shade the house without entirely covering the front. A common fault is to plant too many trees and plant them so close to the house that the shade is too dense and keeps out all the sunshine and much of the air. For this reason as well as for the sake of appearance it is desirable that the trees be so planted that at maturity their branches will not meet across the front of the house. (Fig. 31.)

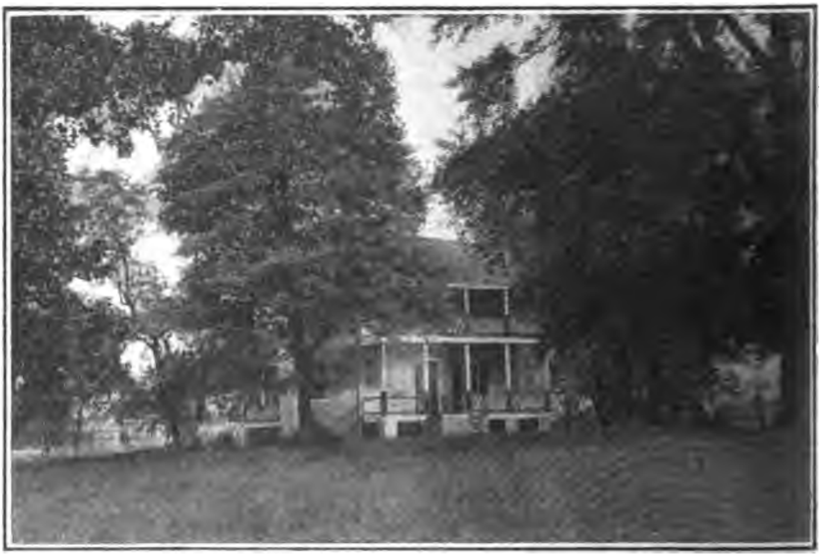

FIGURE 31.—Trees partially hiding a house front

It is usually desirable to have a large shade tree or trees somewhere near the southwest corner, as protection is most needed from the mid-afternoon sun. This may bring them to the rear of the house as a background (fig. 32) instead of as a screen in front. Not only should a portion of the front be seen from the principal viewpoint, but there should be an open lawn as a foreground. This lawn may be bordered on either side by plantings of trees or shrubs, or both, depending on its size and the character of the development. If the lawn extends to the road, this side may also have trees, under the branches of which views of the house may be obtained. If the house is so far from the road that the lawn does not extend across the intervening space, it is usually inadvisable to inclose the road side of it with trees, no matter how large it may be, as that would entirely hide the house from what would naturally be the principal viewpoint. Although it is desirable partially to hide the outlines of all the buildings, it takes from the interest to have them completely hidden. It may be advisable to have some trees on the road side of such a lawn, but liberal vistas should be kept open, so that some good views of the house are obtained.

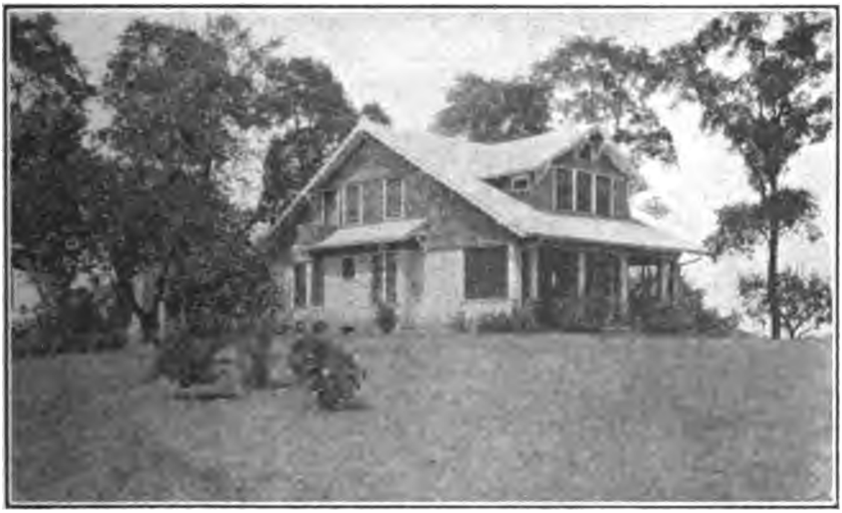

FIGURE 32.—Trees at the back of the house form a frame

The house and its surroundings, as the home center and the most important unit of the farmstead group, has been emphasized in this discussion, but the barns and other buildings also need to be partially hidden. If they have been well located and planned, a little judicious planting of trees and shrubs will so modify their appearance that they will not overshadow the house even though they are much larger.

It must be recognized, however, that this is not as easy to accomplish without interfering with other vital considerations as in the planting about the house. For example, with dairy and stock barns it is not possible, as a rule, to plant close to the south side, because of shading the yards in winter, thus depriving the cattle of the full sunshine and also possibly making the yard a mudhole. In many cases the south is the principal viewpoint. Sometimes, however, trees can be planted to overhang the corners of the barn (fig. 33) or, if it is not too high, can be behind it, partially framing it in foliage. Here, again, care must be used both in selecting varieties and in placing them so that the tops will not interfere with hauling in hay and grain or the trunks interfere with other necessary work.

Paddocks are needed on nearly all farms, and the inclusion of a few trees in the lot is helpful to the stock. When such paddocks can be located between the barns and the road the appearance of the buildings can be greatly improved, while at the same time the land is fully utilized. Orchards frequently can be planned to help in the problem. It is not always easy to find the right solution, but when it is once realized that a barn unsupported by greenery is as much a blot on the landscape as a house so located, efforts will be made to bring about a better condition. The planting should not hide the buildings entirely but should make them less obtrusive by par-

[illegible] hiding the front of a barn.

[illegible] foliage. The barns, like the house, should [illegible] This fault, however, is seldom found about [illegible]

[illegible] trees to screen objects from view [illegible] a hedge or windbreak, although [illegible] may be planned as a grove to equal [illegible] effective when located near the [illegible] a tree or two near the [illegible] the purpose. Caution needs to [illegible] have them too close to- [illegible] so small that it seems [illegible] Frequently trees are [illegible] some of them, but when [illegible] become so attached to them [illegible] longer and a little longer [illegible] the permanent trees are [illegible] small.

Except in the extreme South, only deciduous trees should be used for shade close to buildings, so that all the light possible will be available during the winter, though at a distance of 75 to 100 feet or more evergreen trees can be used either in some of the groups provided for shade or in the screen plantings. A few evergreen trees or shrubs add materially to the attractiveness of plantings in winter.

SHRUBS

A farmstead with trees, without the addition of shrubs and vines, will still appear bare and unfinished. Besides having a portion of their tops hidden by foliage, the farm buildings also need to have much of their foundation hidden. The lines of a building are mostly straight and formal. To make these a part of an informal picture it is necessary to have the straight lines broken and disguised as much as possible. For this reason it is desirable to put masses of shrubs of different heights and widths at various points around the foundations (fig. 34) so as to hide and modify the straight lines instead of drawing attention to them. On the other hand, portions of the foundation should be left exposed, and the lawn should be carried directly to these so that the buildings will appear to be supported. Success in planting is achieved when the buildings appear as though they belonged to the place and fitted naturally together and into the landscape. This is best accomplished by having them rest in a mass of trees and shrubs (fig. 34), while standing firmly on visible foundations. The corners are usually convenient places to plant with tall broad clumps, and these may often be extended into the lawns for a considerable distance. Angles formed by porches, by steps, or by an ell of the building are other points frequently utilized for such groups. Tall groups often may be used also against wide places between windows, while only low ones may be used under windows. Care must be taken not to have the different groups too much alike in breadth, height, and texture of foliage, or in "expression," as it is called.

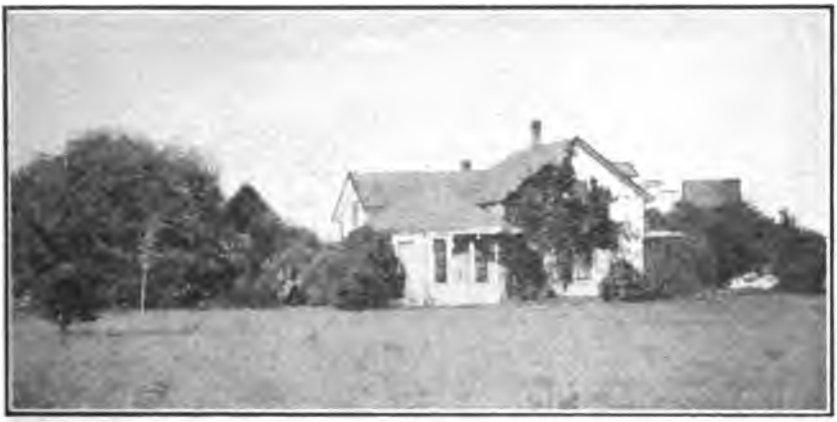

FIGURE 34.—Buildings look appropriate when they rest in a mass of trees and shrubs. Additional trees are needed near the house as a setting and for shade

To emphasize the feeling that the house belongs to the surroundings, the appearance of definite boundaries to the lawns should be avoided as much as possible. On most farms it is necessary to limit rather definitely the ground devoted to the home, but this limitation should not be made any more emphatic than can be helped. As already suggested, it is often possible to have a pasture or a meadow adjoin the lawn with an inconspicuous fence between. Another help to this impression is to disguise the actual boundaries by irregular plantings along them. Where it is possible, distant views or near-by

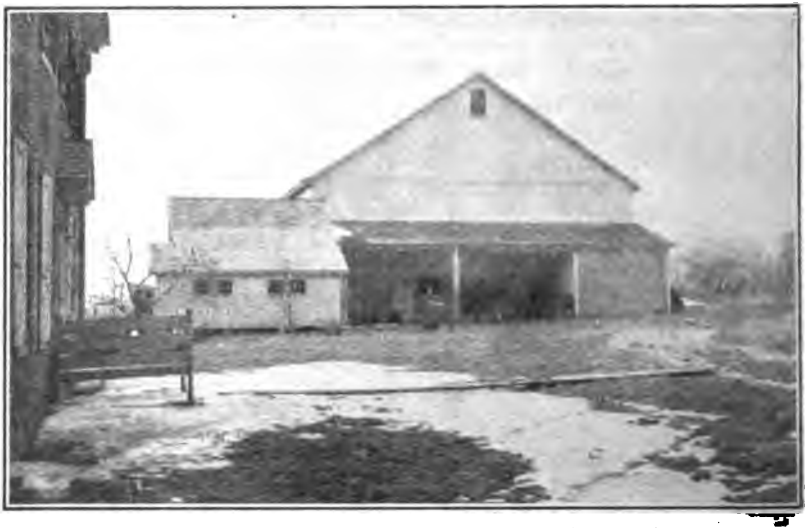

FIGURE 35.—A barn as seen from the front door of a farm home

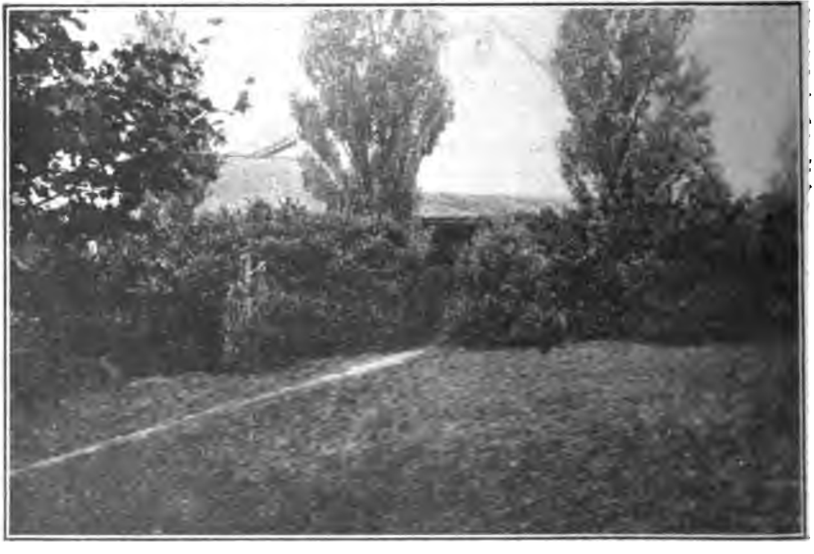

FIGURE 36.—The same barn shown in Figure 35 as seen eight years later

landscapes should be made to appear as though they were a part of the grounds. Much can be accomplished to this end by the proper location of trees and shrub groups on the boundaries of the home lot. Openings should be left in the plantings to expose desirable views from the windows of the most used rooms, porches, or portions of the lawn, and plants of suitable size and height should be used to hide the less desirable outlooks. If there be a broad view, it is usually made more interesting by being divided into parts, as 30°, or one-twelfth of the circumference of a circle, is about as much as the eye can see at one time, and this is as much as should be included in a single view of a distant landscape. If it is necessary to inclose the home lot, the most inconspicuous wire fence possible is desirable, although sometimes a fence covered with vines or a hedge is better. As fences or hedges accentuate the boundaries, they usually should be avoided, and when used they should be made to attract as little attention as possible. Their tendency is to give a "penned-up" feeling rather than the feeling of freedom that especially should be associated with the country home. Sometimes, however, a screen is needed to give privacy. (Figs. 35 and 36.)

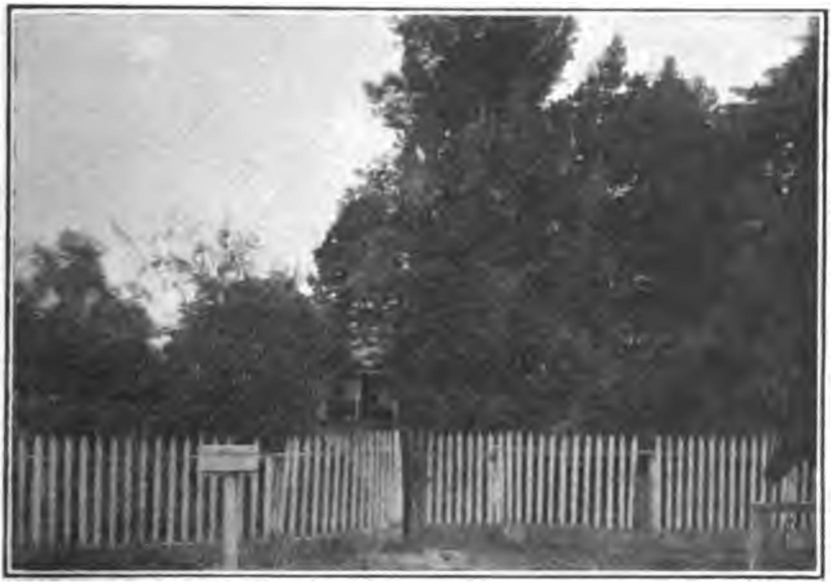

FIGURE 37.—Part of a screen that helps to give privacy and protection from a much-used dusty road

Shrubbery is also used to help outline the course of walks and drives and give an apparent reason for turns (figs. 3, 5, 6, 10, and 12), and to make the surface less conspicuous by hiding it from many points. Such shrubbery must not be so high as to hide traffic at the intersection of walks and roads.

Besides being used on the boundaries to screen less desirable views, shrubs are also useful as screens within the grounds either to hide objectionable views or to give privacy. It is sometimes well to shut off views between the barns and the house (figs. 35 and 36) or between buildings and the highway (figs. 37 and 38), or even to give privacy to a work yard or a flower garden. Shrubs will often do as well as trees for a low windbreak. Besides the utilitarian screening just outlined, interest may be added by partially hiding one part of the grounds from another, simply to pique curiosity. If the whole of an object is seen at one time curiosity is satisfied and interest in it is gone, but if part is hidden it invites exploration. (Fig. 39.) Narrower plantings on either side of such points will leave bays whose depths can not be seen without further inspection. In the same way a clump may be used occasionally to excite interest by partially hiding a portion of the grounds. Not many such groups can ordinarily be used. There is danger of dwarfing the apparent size, especially on small grounds, unless great care is observed in so locating shrubs that they do not obstruct what would otherwise be good vistas. Clumps must have some apparent connection with other plantings and should seem to be a part of border plantings, of base plantings, or of plantings along the drives and walks. A bed alone in the middle of a lawn detracts from the appearance instead of adding to it.

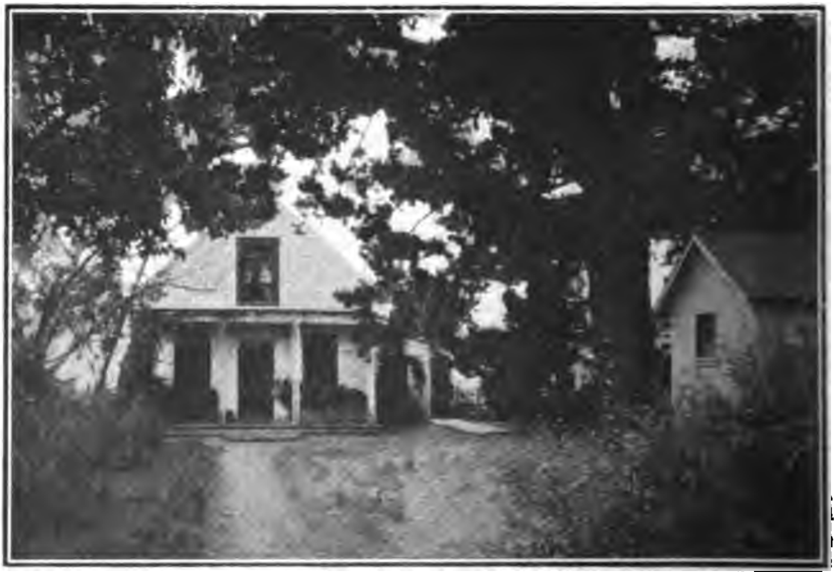

FIGURE 38.—The farmhouse behind the screen shown in Figure 37

An individual plant seldom can be used to advantage. Where a small mass is desired and a shrub has the size and habit required to fill that particular need, then a single specimen may be used. Occasionally a shrub can be set just in front of massed plantings in order to give a variety, but as a rule this result can be obtained better by combining the shrubs differently in the groups.

OTHER PLANTS

Vines are among the most useful plants for "tying" buildings to their surroundings. There is a freedom and grace about their growth that helps to relieve the formality of buildings or fences better than almost any other plants (fig. 2), but care in their selection is necessary. They are also appropriate on fences, arbors, and pergolas, or on summer houses connected with the pleasure grounds or outdoor living sections of the grounds.

Besides the plants already suggested for the principal plantings, herbaceous perennials and annual flowering plants offer a large amount of material that is very useful to add bloom and color where these may be lacking.[5]

PLANT MATERIAL

In planting the farmstead the particular plants used, if hardy and adapted to the region and locality, are of less importance than the general effect of the mass. The expression of the mass, however, is dependent on the combined effect of the characters of the plants composing it. There are great differences of expression between the exclamatory or " look-at-me " impression created by the Lombardy poplar and other tall slim plants and the sympathetic and almost mournful impression given by drooping plants, like the weeping willow; between the sturdy self-reliant attitude, typified essentially by the white oak and the live oak, and the dependent or clinging attitude expressed by vines; between the formal expression of symmetrical rigid-growing plants, like the firs and spruces, and the informal expression of the tamarisk; and between the heavy effect of plants with large dark leaves and the airy effect of plants with small light-green leaves.

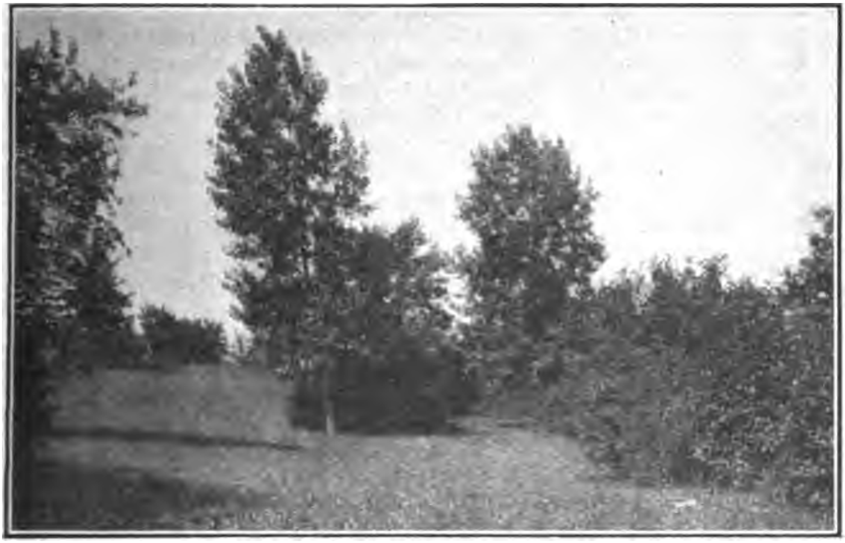

FIGURE 39.—Promontories on border plantings

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[5] For suggestions on growing different types of herbaceous plants to supplement shrubbery temporarily, consult the following publications:
CORBETT, L. C., and MULFORD, F. L. GROWING ANNUAL FLOWERING PLANTS. U. S. Dept. Agr. Farmers' Bul. 1171, 62 p., illus. 1929.
MULFORD, F. L. HERBACEOUS PERENNIALS. U. S. Dept. Agr. Farmers' Bul. 1381, 84 p., illus. 1929.

Plants with great differences of expression should not be used too close together, but should be united by those with intermediate characters. The lines of the different parts of the mass should flow into one another without too great contrasts. Transitions in color and texture should also be gradual. The more unusual the characters of a plant the greater is the need for carefully placing it where it will be most pleasing.

Plants selected for home-ground ornamentation should be hardy in the region, should be comparatively free from attacks by insects and diseases, should have a reasonable quantity of foliage that is not liable to drop from slightly adverse conditions, especially weather conditions, and should be of the proper size, habit, and texture for the location; that is, where a tall upright shrub is needed a tall spreading one should not be used. Most of the plantings should be of comparatively few kinds, although a few specimens of unusual sorts will give variety and add a certain amount of interest. The characters of plants that make them valuable for adornment are (1) foliage, (2) winter effect, and (3) flowers. The importance of foliage is due to its permanency, lasting from five months to a year, depending on the type of plant, the latitude, and the elevation, while the period of bloom is short, usually not more than two weeks.

Next to foliage in importance comes the winter effect. Taking the United States as a whole, the average time that deciduous plants are without foliage is at least five months. During this period the farm home is occupied as continuously as in summer, and the surroundings should be as attractive as possible. Evergreen shrubs, both coniferous and broad leaved, maintain a color throughout the winter not otherwise obtained. Used in moderation, they are a distinct addition at this season. On the other hand, many deciduous shrubs have attractive winter characters, the most striking being bright-colored berries. Then there are barks of many shades of brown and gray, with some of bright red, green, and yellow, that if properly arranged make pleasing contrasts and add to the winter beauty. The short blooming period of the average shrub makes flowers the least important of the characters to be considered. In spite of this, the color, character, and time of blooming should be considered, as well as the behavior of the dying flowers, whether or not they fade to a conspicuous and undesirable color and hang on unduly or pass away without a distinctly unsightly stage.

The different kinds of plants should be selected so that they will give bloom through as much of the season as practicable, thus affording something of special interest as continuously as possible. The bulk of the planting, however, should be of a few species. Eight to a dozen kinds are enough for an ordinary place. With this small number, selected as far as practicable to bloom at different seasons, there is little danger of getting color combinations that will not harmonize. Where especially bright colors are selected, others should not be chosen for growing next to them during the same season unless they harmonize. Near brick buildings, or buildings painted with bright colors, care must be exercised in selecting shrubs with colored flowers. White flowers are always safe and can be used to help in giving other flowers an appropriate setting. A plentiful use of the different greens or a mixture of many colors is also safe.

It is only when one or two colors are selected for use in quantity that danger of lack of harmony arises.[6]

In addition to locating clumps of shrubbery at appropriate places on the grounds, the placing of the various kinds of plants in the clumps has an important relation to the ultimate results. It is usual not to plant many clumps of a single kind. A mixture of plants of similar size in each clump often gives pleasing results. One clump may be composed of one-half of one variety, one-fourth of another, and the rest of other kinds, while another can be nearly equally divided between two kinds, and still another can be three-fourths of one kind and the remainder of any combination. Where a large quantity of one variety is used in a clump, it is well to have at least a few of the same plants in some of the near-by groups. In nature, trees and shrubs are mostly found in large quantities, either almost alone or well mixed with other plants. As the boundaries of these areas are reached, the plants are found in more or less scattered clumps, until the place is reached where there are none. In a similar way the plantings should be in comparatively large masses with scattered plants in other near-by clumps, as shown in Figure 40, where the arrangement is indicated by different numbers for different kinds. The plants should be set at irregular distances apart, so as to avoid being in lines in any direction.

By making a few clumps largely of one kind of shrub and by scattering plants of it in others, the impression may be given of the yard being full of this plant when in the height of its bloom. Then, by having another shrub predominate in other clumps with more scattering plants a similar impression may be created for another plant of another season. Other kinds can then be restricted to limited portions of the grounds. If for any reason it seems desirable to use a certain shrub only in one particular clump, this clump can be made to appear to belong to the rest of the planting by including in that mass a specimen or two of the shrubs predominating in the adjoining groups. Most clumps need plants of different heights, the taller ones at the back, the shorter in front, and plants of any height may be used for "tying" them together. More than one height of plant may often be used for this purpose.

The kind of plants to use is of less importance than their location upon the grounds. In all sections of the country there is native material that is more desirable for local planting than most of the plants brought from other places. The more trying the conditions for plant growth, the more important it is to secure native species and stock of the commoner things that have been grown from seeds or plants gathered near home. There is wild material in every neighborhood that is more suitable for planting in that locality than nine-tenths of the plants described in the catalogues. The common wild plants of any neighborhood should be largely used for home planting. Although many may be so common they have gotten in the way of cultivation, still they may be beautiful and have value for ornamental planting. (Fig. 41.) Nearly all improve with culture. Where possible to collect them from their native habitat there is a satisfaction in the final results that is not obtained from purchased material.

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[6] For a fuller discussion of this subject consult Farmers' Bulletin 1171.

Those collected in the vicinity are usually more difficult to transplant successfully than the same sort of plants purchased from a nursery. This is because in the wild the roots have never been pruned and so have run to long distances, with the result that when the plant is dug

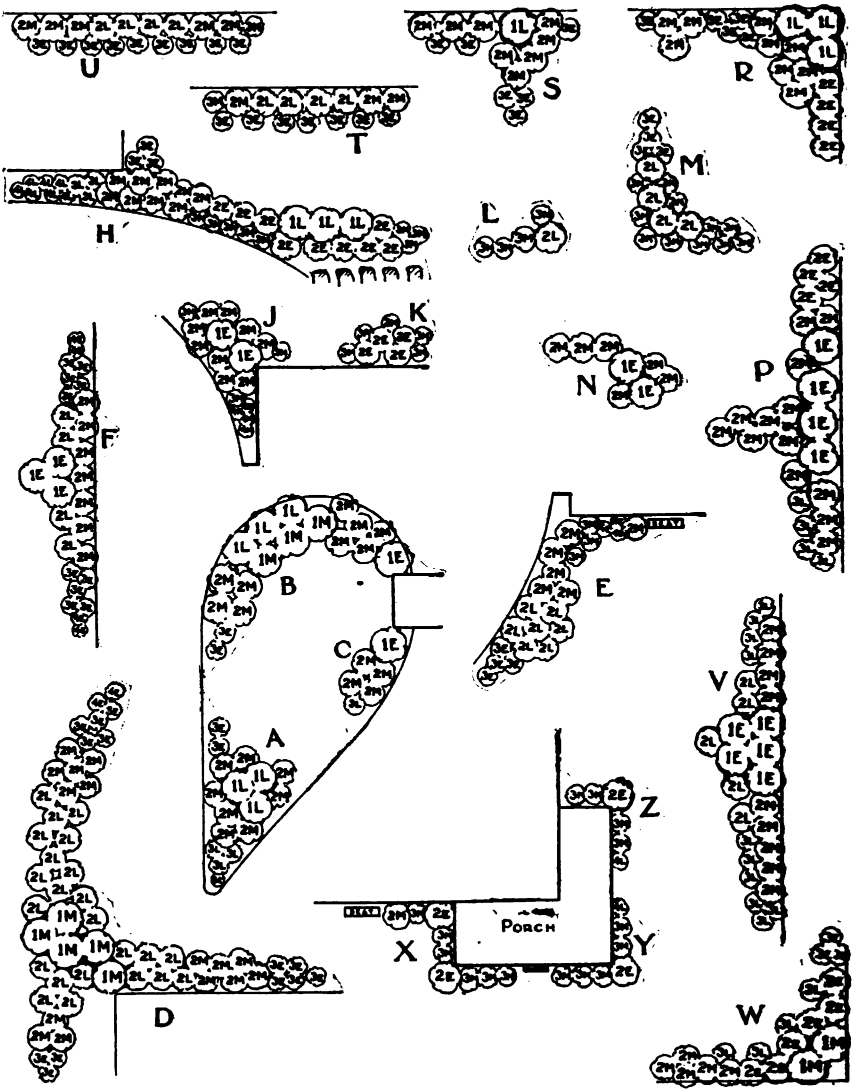

Figure 40.—Sketch showing the plant arrangement in the groups illustrated in Figure 12. The number signifies the height of the shrub: 1, Large, 10 to 15 feet; 2, medium, 6 to 10 feet; 3, small, 2 to 6 feet; 4, low, 1 to 2 feet. The letter signifies the period of bloom; E, early; M, midsummer; L, late

more roots are cut off than when taken from a nursery where they have been root pruned frequently.[7]

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[7] For information on methods of transplanting and on collecting plants from the wild, consult the following publication: Mulford, F. L. Transplanting Trees and Shrubs. U. S. Dept. Agr. Farmers' Bul. 1591. 34 p., illus. 1929. [In press.]

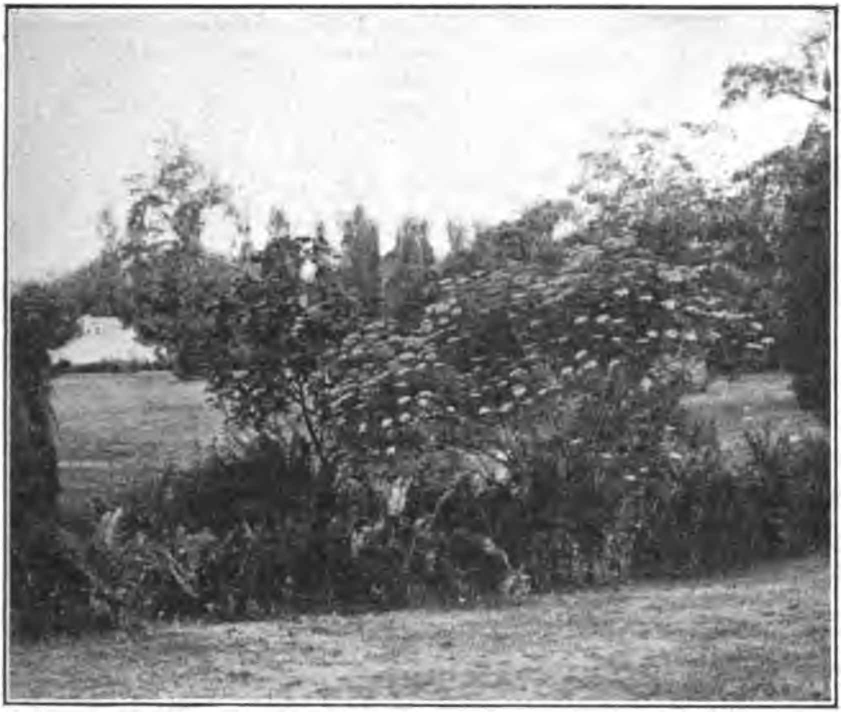

FIGURE 41.—A handsome native shrub, the elder. It grows nearly everywhere in the United States

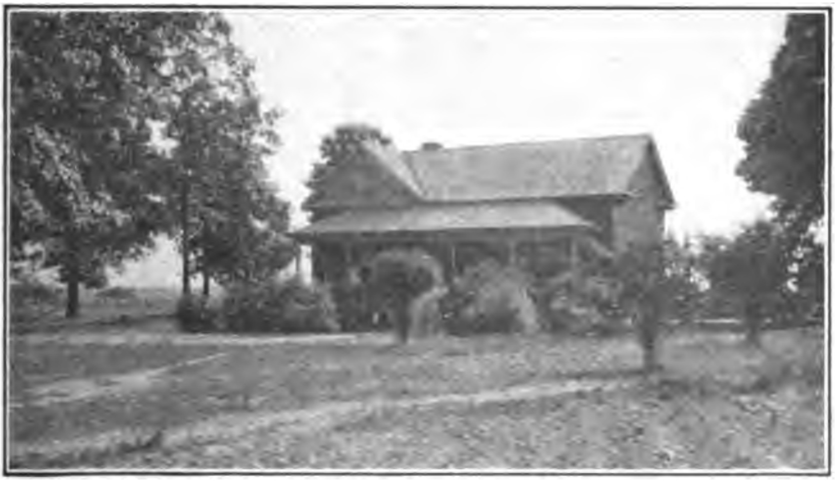

FIGURE 42.—Shrubs that need thinning. Too much of the foundation line is hidden, and the house seems smothered by them

If the plants are to be purchased, a reliable nurseryman located where the climatic conditions are as nearly like the local conditions as possible should be selected. The stock should have been produced from seeds or cuttings grown near home rather than from plants grown under different climatic conditions, as the plants will be likely to be hardier and better adapted to the local conditions. A partially tender plant is always unsatisfactory.

There are two methods of setting shrubs for ornamental effect. One is to set them as far apart as they should be when they reach maturity, and the other to set them more closely and from time to time remove some of them. With the first method it is necessary to use annuals or perennials between the shrubs for a year or two in order to have the beds and clumps filled. This usually does not e tail much extra work, as such plants are frequently wanted at s point on the grounds or in the garden for their bright summer eff The difficulty with the second method is that the thinning is likely to be done as soon as it should be. (Fig. 42.) Where part of the spaces set aside for planting are ready, the plants all the spaces may often be put where the beds are prepared, then the extra plants can be taken to the place designed for them as soon as the beds are ready. In this way, too, it is possible to start with smaller, cheaper plants than where an immediate result is attempted with permanent plants only.

After trees and shrubs are planted they will need hoeing manure for two or three years until well established, when they for the most part, take care of themselves, unless rapid growth consideration; then the manuring and cultivation should cont After becoming established they will need little pruning further t to remove dead or broken wood. If a mistake is made in the orig selections, so that the plants of a wrong size, habit, or texture placed at any point, no hesitation should be felt about correcting error by removing them and putting appropriate plants in th places.

U. S. GOVERNMENT PRINTING OFFICE: 1929

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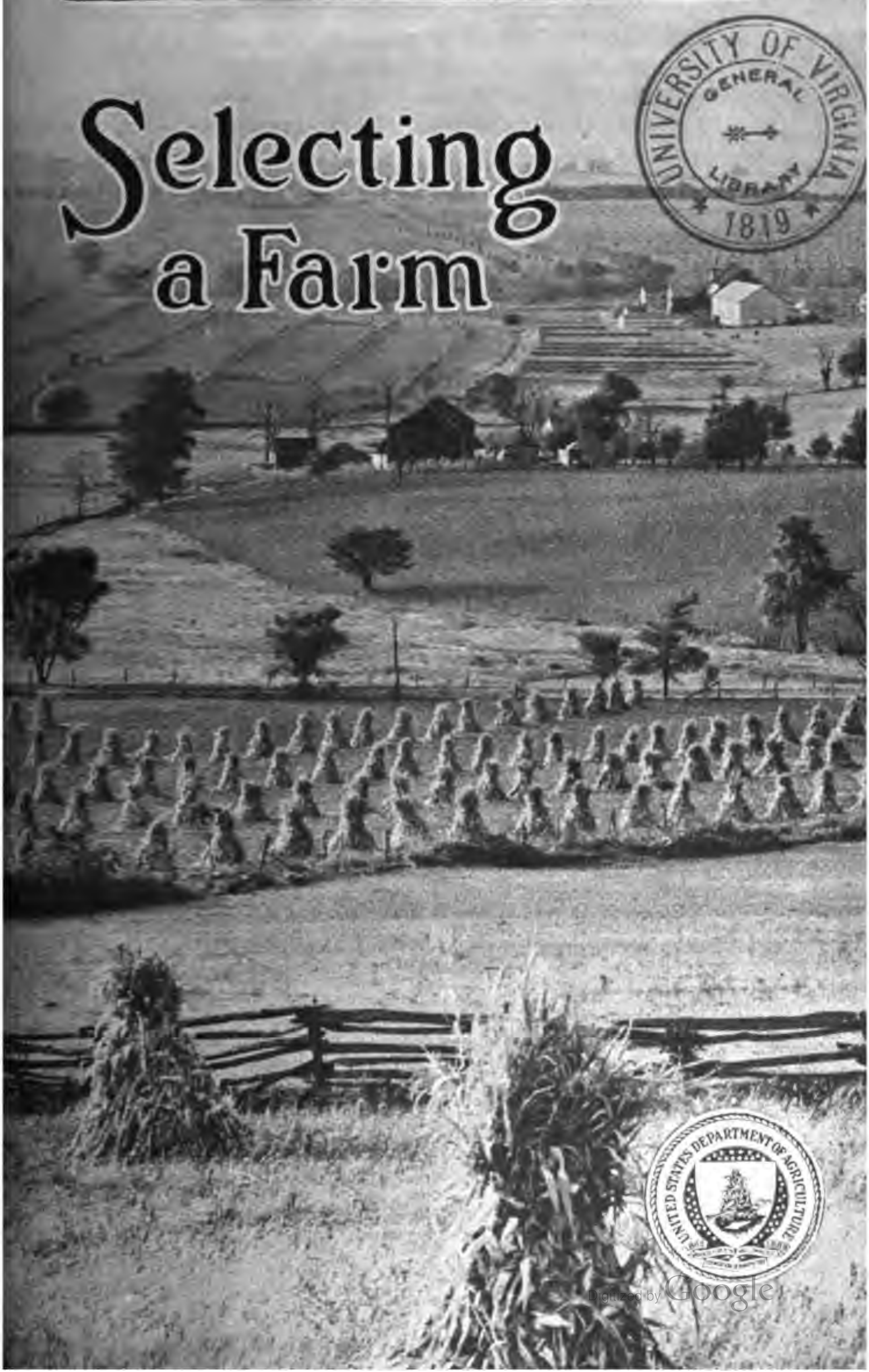
FARMERS' BULLETIN 1088
UNITED STATES DEPARTMENT OF AGRICULTURE

Selecting a Farm



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THIS BULLETIN is designed to aid the prospective buyer or renter in the choice of a farm. It is written for those who already have had some experience in farming, rather than for the uninitiated, and is intended primarily to afford suggestions to the farmer whose training has been rather limited, or to the more experienced man who contemplates moving to an unfamiliar locality or changing to an unfamiliar type of farming. It is assumed that no one wholly without experience in farming would be so rash as to choose a farm on the strength of knowledge gleaned merely from a bulletin on the subject.

Office of the Secretary
Contribution from the Office of Farm Management
H. C. TAYLOR, Chief
Washington, D. C. March, 1920

SELECTING A FARM.

E. H. Thomson.
Formerly Assistant Chief, Office of Farm Management.

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THE WISE SELECTION OF A FARM is vital to the success and satisfaction of farm life. Choosing a farm often means choosing a place in which to live and work for a lifetime. It is important, of course, to decide wisely in buying for investment, but in making a selection for a home it is of double importance that one consider the various features that may have a decisive bearing on the farm business or that may affect the home life. It is the purpose of this bulletin to bring some of these points to the reader's attention so that he may be in a position to view the matter on all sides, and weigh the advantages and disadvantages before buying or renting a particular farm.

It has been said that we are creatures of environment. If this is true of any class of people it is true of farmers. The farm boy travels in his father's footsteps, all too often without attempting to gain a broader vision through acquaintance with conditions other than those that have shaped his father's life. The conservatism of the farmer is primarily based on the fact that generally he is a student of none but local conditions. When a person has been trained in only one kind of farming he is very apt to look at another kind of farm business with prejudice. The dairyman can see only dairying. He wants cows everywhere. He thinks in terms of cows, acres of silage corn, and tons of hay. A fruit farmer can see nothing but fruit, and habitually thinks in terms of the fruit business.

It happens that many farmers, especially the younger men, in moving from one region to another, make serious errors in their selections of farms, not that their judgment is naturally poor, but mainly because they know only one set of conditions and are not able to measure accurately all the new factors that must be taken into account in choosing their new location. It is here that the science of farm management is helpful, in that from the farm-management viewpoint the farm is put on a business basis, so that all the influences which may have a bearing on the profitableness of this business are considered.

In doing this, however, the home side of the question must always be kept in mind. The farm home and the farm business are inseparable. A desirable farm, from a business standpoint, is nevertheless undesirable if it has no social or community advantages. On the other hand, desirable living conditions are of little or no advantage unless supplemented by a successful farm business.

A farm may have fine buildings, good water supply, splendid roads, and other assets of this nature, yet if the soil is rocky, shallow, or naturally infertile, so that its productive possibilities are distinctly limited, there will be no adequate income wherewith to enjoy the other advantages. Moreover, these physical limitations are enduring, while the needed improvements, such as buildings and roads, can be added as means are provided.

It is fully realized that many persons select certain regions or certain farms largely for personal reasons. In such instances the personal factor outweighs all others, and the question of the desirability of the farm from a business standpoint is comparatively of less importance.

It is obvious that few farms possess all of the desirable features and that it is often sound business to invest in a farm or in land even though it has certain undesirable features. Naturally, the particular circumstances and the purposes for which the individual desires a farm will always be taken into consideration in making a selection.

TRAINING AND EXPERIENCE.

It is assumed at the outset that the prospective farm buyer or renter has sufficient training and experience along agricultural lines to justify him in making the venture. Successful farming is not easy. It requires large experience in doing the various kinds of farm work and the ability to show others how to do this work. It also requires training in business management, and knowledge of the principles of plant growth, the feeding and care of animals, and the maintenance of soil fertility. Few industries require such a wide range of training and experience. Farming is not simply growing a particular crop or feeding a certain kind of live stock, but is an all-the-year-round business, involving the production of various plants and animals and the successful organization of the varying farm enterprises into a smoothly working unit.

To obtain the needed training and experience on one's own farm is usually expensive. It is much cheaper for the beginner to get the preliminary training by working for another farmer.

The writer's father, in speaking of his farming experience, said: "If anyone could have told me at the outset the things I have had to learn through 50 years of management of this farm, years of experiment would have been saved and success made very much easier."

Although the suggestions outlined in this bulletin are primarily for the beginner and less-experienced person, nevertheless it is assumed that no one entirely unfamiliar with agriculture would presume to buy a farm after merely reading a book or bulletin on the subject.

In buying a farm, a city man should bear in mind that he is in much the same position in choosing a home and business in the country as the farmer would be if he went to a city to purchase a home and place of business. Lack of experience and information in either case is usually expensive.

Many of the finer points that an experienced farmer would note in inspecting a farm can not be discussed here. The experienced farmer, when choosing a farm of a familiar type, does not need a score card in making his selection.

TO BUY OR TO RENT?

In choosing a farm one has the following options: (1) Buying a farm with the intention of operating it as his entire business; (2) buying a small farm and renting enough additional land to meet his needs; (3) renting a farm either on a share or cash basis.

The question of whether to buy or rent can not definitely be answered here, but the suggestions as to the benefits derived from the use of capital and size of the farm business apply in either case. One's choice in this matter is usually determined by the funds available.

If one has only a small amount of capital and wishes to undertake farming as a business from which to derive his entire income, he should, in nearly all cases, begin as a renter. However, if he wishes to buy a farm on which to live, deriving a part of his income from other sources, then possibly purchasing is desirable, even though capital is limited.

Again, in many cases if one is able to purchase a small farm it is possible to develop this as a basis of operations and rent additional land in the neighborhood. This is not an altogether desirable method of operation, as one can never be sure of suitable lands being available. It is an expedient, however, that enables one to operate a much larger business than he could otherwise with the amount of capital he has, and at the same time have a home which he can call his own.

Whatever course is followed, it is highly desirable that one thoroughly understand the basic business principles governing the farm business before attempting to decide some of the finer points. A disregard of these basic principles is responsible for a large percentage of farm failures. A man may unconsciously work all his life against some unsuspected economic barrier, when success would have been comparatively easy had he selected a farm where the economic principle would aid him instead of working against him.

THREE VITALLY IMPORTANT FACTORS.

To achieve success in an ordinary farming venture it is almost essential to have these advantages:

1. Opportunity for a paying size or volume of business.
2. A type of soil or kind of live stock that will yield returns that more than cover the cost of production.
3. Suitable conditions, both as to natural resources and environment and as to markets, to permit the development of a dependable organization of diversified activities.

ADEQUATE SIZE OF BUSINESS.

Other things being the same, the net income from a farm is directly affected by the size of the business. If the gross income is small the net income must necessarily be relatively small, no matter how economical the management. In earlier years the amount of hand labor available largely controlled the size of the farm business, but under present conditions the determining factor is not what a man actually may accomplish with his own hands, but what he can accomplish with the aid of teams, machinery, and other agencies.

Land, buildings, and equipment are economically valuable only in so far as they can be used for productive purposes. The real income from a farm is derived from three sources, namely, returns for the use of land, returns from working capital, and returns for labor expended. If both capital investment and labor expended are small, the income must necessarily be proportional. Capital working alone in the farm business will not yield an income; a man may have plenty of land to work, but if he does not work it he gets nothing. Then again, if he has but a small acreage, or an acreage that gives but limited opportunity for profitable work, he necessarily is limited in income from his labor. It is possible, of course, to conduct a large business on a small acreage, but intensive farming, such as market gardening, can be carried on only with a great expenditure of man labor. The man who chooses to farm an acreage too small to permit the free use of labor-saving implements should understand that a convenient market for his products and a relatively large application of manual labor per acre are essential to even a moderate success. (See fig. 1.)

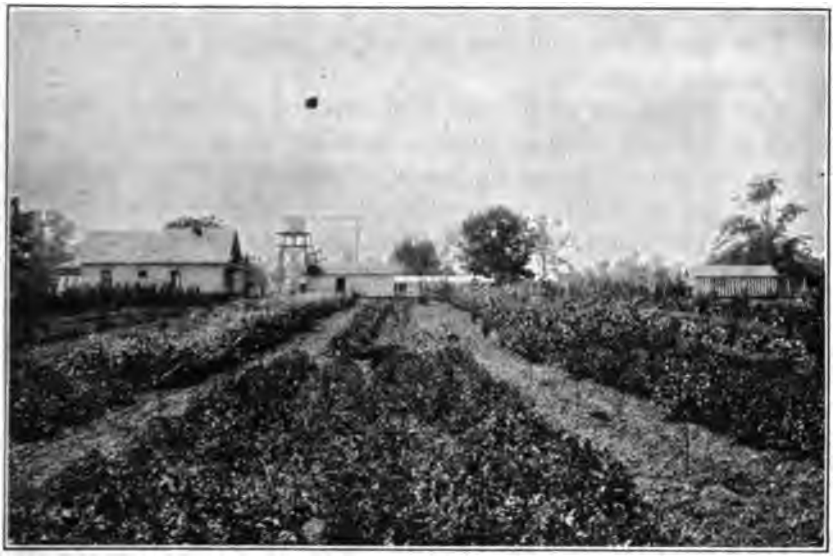


FIG 1.—This kind of farming necessitates a great expenditure of hand labor.

It should be borne in mind that it requires a farm business of considerable size to provide an income that will merely cover maintenance charges, and that these charges are relatively larger for small farms than for large farms A farm may be of such a size as to furnish most of the supplies needed in the farmer's living, such as garden, fruit, etc., and enough income to pay the taxes and running expenses, but unless there is a margin above this annual maintenance charge no progress can be made toward accumulating a surplus.

This point is often overlooked, and thousands of men fail to understand why they do not get ahead faster, when, as a matter of fact, the size of their business is such that there is only a remote possibility of any margin being left after obtaining a bare living and paying absolutely necessary running expenses. Often the income is insufficient even to do this, and the farmer and his family have to go without some of the comforts of life.

Thus it is that the size of the farm business is one of the most important if not the most important factor to be considered in selection. In evaluating a farm in this regard it is essential to make sure of three things:

1. That you have an opportunity. That is, make sure that the desired volume of business is at least potentially there, as evidenced by tillable land or by markets for intensive crops on small areas.
2. That the volume of business can be achieved by economical methods.
3. That the volume of business that can be conducted on the farm is such that it will yield an income large enough to provide a comfortable margin, after paying the absolutely necessary expenses of operation and providing an adequate living for the farmer and his family, for saving or future demands.

The watchword should be "opportunity," and opportunity hangs upon two factors, either of which is of no avail without the other: First, room to use capital and labor economically, and second, a place to market the harvest.

Only recently an object lesson in this regard came to our notice. A young man, born and brought up on a farm, who had financial backing from a well-to-do farmer, selected a farm in the neighborhood for his permanent home. The farm he bought was such as profitably to use the labor of but one man for only a part of the year. It was 160 acres in area, but rugged, rocky, and incapable of development for any type of farming that could be profitably carried on in that region. No amount of planning could make that farm produce more than a meager income. It had markets, good neighborhood and other desirable features, but offered no opportunity to work and develop a business to advantage. Of course, such a farm could provide work for several men digging rocks, or laying tile drains in soils too shallow to be worth draining, or putting up buildings which would never be filled with crops, but none of this work would be worth while, even though it might utilize the time of several laborers and keep the owner himself busy, since it could not be done at a profit. As long as he stays on that farm the young man can never hope to make more than a meager living, for the basis of an adequate income is not there.

Take another case, of a different nature, but illustrating the same point. A young man selected a farm of excellent soil, with favorable climate, good buildings, good roads, and desirable social conditions, and undertook to conduct a business along intensive lines with the intention of having as much of a business on 20 acres as there would be on a 120-acre general farm. His failure came when he found, after the season's crops were grown, that he did not have markets for the products derived from that type of farming. This young man did not have capital to buy a larger area, so he planned to put a large business on a small area. This would have been all right if he had had available markets for his products. If he had selected such a farm near a large city or other suitable market he might have succeeded, though in that case the price of land would probably have been prohibitive.

HIGH QUALITY OF BUSINESS.

It is obviously essential to the success of any farm to grow crops and to keep live stock that return enough to pay more than the cost of production. On a certain farm it took 32 bushels of corn to cover the bare cost of growing the crop. When the farmer harvested 33 bushels he had a margin of but 1 bushel over and above the cost. On a farm across the road it took 34 bushels to pay the cost of growing the corn, but the farmer harvested 50 bushels—a margin of profit 16 times greater than that of his neighbor. Such margins represent the difference between success and failure.

In choosing a farm be sure to see that the prospects are for crop yields more than sufficient to balance the cost of their production. It is plain common sense that good crops are better than poor crops, and that good cattle are better than poor cattle. Soils of low fertility are a handicap; indeed, some soils are a positive liability if one has to farm them. It is well to inquire thoroughly into yields, not only those that have been obtained on the farm itself for a series of years, but those realized on adjacent farms. Learn whether poor crops are due to poor soil or to bad management. If yields are very high, inquire carefully as to how they are obtained, and judge for yourself as to the economy of the methods used. If the yields have been very low, it may be that the better management or improved methods which may be put into effect will make possible the production of profitable crops; but before buying in such a case, make doubly sure that the land is capable of improvement.

Equally essential to the success of the farm business is high quality of the live-stock enterprise; that is, handling live stock so that they will pay for feed, care, and labor. This is more than a matter of management, for it is dependent on cheap roughage, pasturage, market, and getting labor at reasonable rates.

We must not confuse the quality of the business with the question of prices for which the products are sold. A man may be growing excellent crops or have very fine live stock, but the prices he receives may be so low as to make even high yields and good live stock unprofitable. More often, however, failure in the farm business is occasioned by low yields and poor live stock when the products are marketed at prevailing prices. The chances of success are with the man who grows a good crop and keeps at least a fair quality of live stock.

ADEQUATE DIVERSIFICATION OF FARM BUSINESS.

Diversification of the farm business, as represented by the production of several salable products, lessens the risk of loss from crop failure and low prices, promotes better utilization of teams and machinery, permits rotation of crops, and on the whole is conducive to the safety and stability of the farm business.

If the farm selected is so situated that it is desirable to grow only one product, one should be very certain as to the reliability of that product, both as to production and as to sale. If the climate is such that only a limited class of crops will thrive or mature, the growing season may be so short that certain crops essential to a good rotation can not be grown. Make doubly sure that climatic conditions, such as rainfall, period of drought, late spring or early fall frosts, hailstorms, strong winds, hot winds, fogs, and humidity do not seriously limit the development of a diversified farm business. It is generally possible to grow some crops, but can all those needed be grown so successfully as to insure a well-balanced farm organization? Many farmers have failed through failure to give proper attention to this question.

Equally important in this regard with market and climatic limitations are soil and topography. A soil may grow beans, corn, oats, and timothy, but not clover, an essential crop for many rotations. The soil may be too sandy for some crops. It may blow badly or wash when intertilled crops are used in the rotation. It may be too poor, or subject to leaching, or alkali, or drought. These conditions may not necessarily limit all the crops, yet be so unfavorable as to limit certain crops on which proper diversification of the business must be built.

AMOUNT OF CAPITAL.

The outlay of capital in the farm business is generally a question not of how much to invest in the business but of how much of a farm business can be undertaken with the funds and credit available. In the case of those having plenty of capital, the amount needed to finance the business is governed by the size of the farm they may choose to operate.

It is important to bear in mind the necessity of a proper distribution of one's capital among the items of land, equipment, live stock, supplies, and cash for operating expenses. A poorly balanced equipment, either in point of live stock, machinery, or other features, may seriously limit the farm income. Lack of enough horses to do the work, or of the necessary live stock to consume the hay or roughage is a serious handicap, particularly for the beginner. On the other hand, investment in expensive items of machinery or improvements may well be postponed for a few years, the primary object at the beginning being to equip the farm with those things which will count from the outset toward the making of an adequate net income. Later, as profits are realized, other improvements can be added. Over-investment in buildings is a common fault of beginners and not uncommon among farmers in general. Expensive buildings entail a heavy annual charge against the business. (See figs. 2. and 3.)

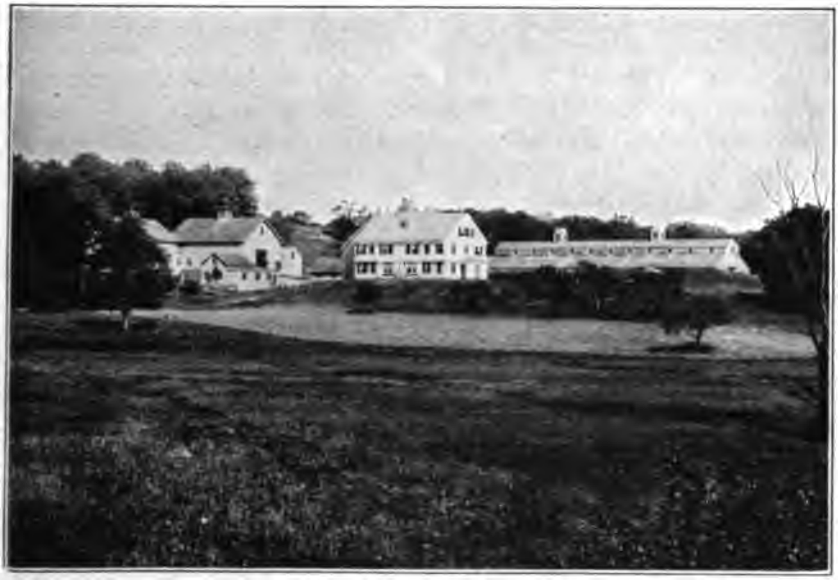


FIG. 2.—A "show farm" on which overhead expenses were so great that the business lost money.

The proportion of the total investment in land and in the various items of equipment should vary according to the price of the land and the kind of farming followed. In a general or diversified farming business, that is, growing staple crops, with dairy cows, hogs, or other cattle, from 70 to 80 per cent of the total farm investment will be required by the land and buildings. On truck, fruit, grain, cotton farms, possibly 90 per cent may be represented by real estate. The amount of cash necessary for running expenses will vary from 1 to 3 per cent of the total investment. This will depend largely on the way the annual income from the farm is received. On dairy farms the checks for milk or cream are received every month. These furnish funds for running expenses and a smaller amount of cash is needed for operating expenses.

The successful farmer, however, usually keeps funds at hand to use for bargains should occasion arise. Cattle may be going at a low price at a neighborhood auction or the farmer may have opportunity to buy second-hand machinery to replace that worn out. Many farmers buy much of their equipment in this way. The amount invested in machinery, tools, etc., will usually range from 2 to 5 per cent of the total farm investment. The remainder of the funds will be represented by live stock, feed, and supplies, the amount of the latter depending largely upon the season of the year and the number and kind of live stock kept.

FIG. 3.—Farmstead of a successful Corn Belt farm. Buildings ample for the large business, but not expensive.

With limited capital it is a common practice to buy as large a farm as possible with the amount available to cover the cash payment required at the time of purchase and still have enough funds to equip and operate the farm selected. Thus, if the buyer had $5,000 in cash he might invest his funds somewhat as follows: He selects a farm costing $8,500, of which $6,000 could remain as a first mortgage. Thus he places $2,500 in land as a cash payment at time of purchase, giving a mortgage for $6,000. This leaves $2,500 for equipment and operating expenses. He might put $600 in machinery and tools, $1,200 in work stock and other live stock, $300 in feed and supplies, and $400 in cash to carry on the business. These are only approximate figures and will vary considerably according to the farm selected.

Usually for a beginner in the farm business the amount in cash should exceed that ordinarily used by a farmer in a well-established business, as more funds are needed in getting started than later when the business is well established.

Only a rough approximation can be given of the number of work stock necessary. On general farms having more than 100 acres in crops there should be one work horse for every 20 to 25 acres of crops; on Eastern farms having 50 acres or under in crops one horse to every 12 to 15 acres of crops, and on cotton farms one mule to every 12 to 16 acres of cotton plus 8 to 10 acres of corn and other crops. As the size of the farm increases up to a certain point greater efficiency of work stock and machinery is obtained and each work horse or machine works a larger area. Observation as to the number of horses needed on neighboring farms of the same size is an excellent guide in this matter.

Farm management investigations have shown conclusively that there is a very marked increase in efficiency in the use of men, horses, and machines on medium-sized farms over small farms. Why this is true is obvious when we stop to analyze the problem. If your horses work only 15 acres of crops each and the horses of your neighbor across the road work 20 each, and you both sell your products to the same market, you necessarily have to bear a higher expense for horse labor. If your mowing machine cuts 25 acres a year and stands in the shed 360 days out of the year, and your neighbor's machine cuts 75 acres, your machinery charge per acre of hay cut must necessarily be higher than his.

Even on small farms occasions are constantly arising when at least two men are needed. One may be required to keep the team busy while the other goes to town for supplies, or does the chores, etc. Many operations require two men to perform them to advantage. One man in a general farm business, without help, can hardly work sufficient land fully to utilize his teams and machinery to the best advantage.

So far as investigations on this subject have progressed, no marked increase in efficiency of men, horses, and machines is obtained on very large farms over medium-sized farms. Stated differently, there is a pronounced increase in efficiency on a medium-sized farm over a small farm, but beyond a two-man farm, or one on which from 20 to 25 acres of crops is covered per horse, there is no substantial gain in efficiency of men or teams by reason of larger acreage.

The typical American farm, generally speaking, provides work for the farmer and one additional worker. In many cases the additional help is the farmer's son or some other member of his family.

ADAPTABILITY TO CHANGING ECONOMIC CONDITIONS.

In choosing a farm, it is well to bear in mind the probable effect of changing economic conditions. Certain crops may cease to be profitable, owing to the development of other regions more favorably situated for their production and marketing. Some crops may have to be abandoned because of disease, insect pests, etc. The question should be asked: Is the farm selected adapted to such possible changes?

For instance, suppose the farm selected is now growing beans, potatoes, corn, oats, clover, and hay, with the prospect that beans and potatoes will soon cease to be profitable. Can some other crop or crops be found to replace them? Very few regions have a wide range of crops, especially in general farming, and adaptability to new crops is a very important consideration.

Can the beef-cattle farm be made over into a dairy farm? Can the dairy farm be made into a sheep farm? Can the fruit farm be made into a hay, grain, or live-stock farm? In many instances it will be found that the farm in question demands an inflexible type of farming that can not be changed to meet the exigencies of changing conditions.

The history of American agriculture is filled with thousands of illustrations of agricultural evolution brought about by the great development of agriculture in the movement of settlement from East to West. Many of the greatest mistakes of the present generation have been made in this particular. Men have selected farms which were all right at the time, but in a few years, with changed market conditions, their whole business has been ruined, leaving them with farms on their hands which did not admit of reorganization or readjustment. Such failure may result from having too small an area for general farming, or from having soil not adapted to the production of staple crops. The Eastern States are strewn with rundown farms that were profitable under the conditions of a generation ago, but which can not be adapted to present-day conditions with respect to labor, use of machinery, transportation, etc. This is one of the important factors responsible for the low price of land in some of our Eastern States.

The West also has made many serious mistakes in the same way, even within the last few decades. (See fig. 4.) Many farms, selected with a view to some special type of farming, are found to be altogether too small to be efficient or profitable when a more stable or diversified business becomes necessary.

This mistake is made both by experienced and by inexperienced farmers. Experienced farmers make the error when the change is to a new type of farming, such as a grain farmer going into fruit growing or a small back-yard poultry grower going into a large poultry business.

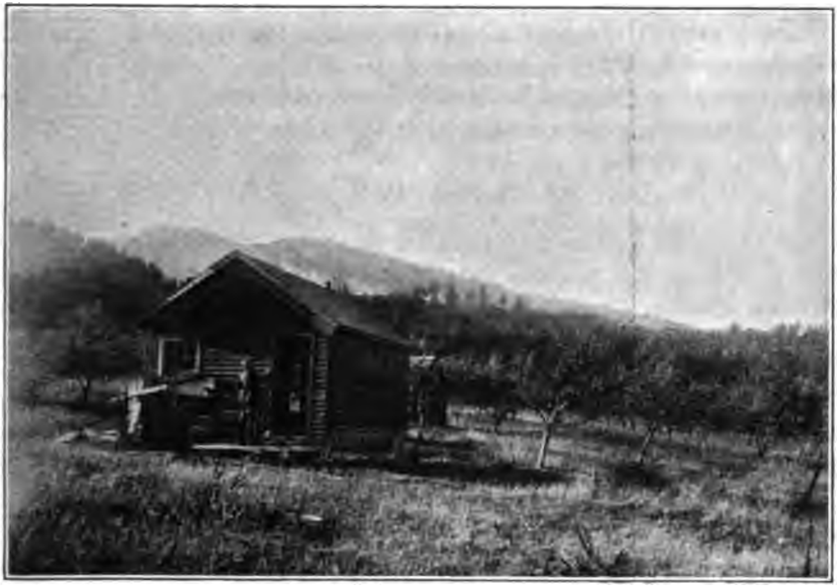


Fig. 4.—A deserted orchard farm in the Northwest. The owner of this place failed because of poor soil and lack of irrigation.

When making a selection, look back and follow the local economic changes that have occured in the last 30 years, and then judge for yourself whether the farm you have under consideration has the adaptability necessary for meeting the changes that are bound to come in the future.

CAN A HIGH QUALITY OF FARM BUSINESS BE MAINTAINED?

A point that needs special emphasis in this connection is the capacity of the farm for the maintenance of a high quality of business, as evidenced by good crop yields, good pastures, and feed for live stock.

The yields may be satisfactory at the outset, but, as the soil is broken and cultivated, are conditions such that these yields can be maintained? Often the soil is soon exhausted by reason of the fact that most of the humus is on the surface. Again, the land may soon become sour or alkali from poor drainage. Many soils when cleared of timber and broken up deteriorate rapidly, even under good management. Their fertility is only on the surface and they are easily and quickly impoverished.

In live-stock farming an important factor is plenty of cheap roughage. A farm that permits of the production of such feeds, for instance, a place with good pastures, is more desirable and likely to have a greater range of adaptability than one that lacks this important attribute. An inexperienced person should be especially cautious in this regard, and be careful not to select land which, under good management, can not be kept in a productive state.

LOCATION.

The choice of a farm as to climate and kind of farming to be followed, is largely a personal matter. One may prefer the kind of farming that is carried on in a Northern State, another may like the climate of a Southern State. Again, a man may have personal reasons for taking up dairy farming, or fruit farming, or some other type. It is not possible to outline here the advantages and disadvantages or points to look out for in each type of farming which may be found in different parts of the country. If one has a preference for a particular type of farming, as a general proposition he should go where that type is well developed, which fact is an indication that conditions are favorable for it. Embarking on an entirely new type of farming in a region where it has not been heretofore followed is an exceedingly hazardous undertaking. Sometimes it is successful, but the chances are that there are some very good reasons why such a type of farming is not found in that region. However, a man who is intensely interested in a special type of farming might make a success of it in a comparatively unfavorable region by reason of great care and skilled management, whereas others, who were not so experienced in this kind of an undertaking, would fail.

A very common mistake of city persons who take up farming for the first time is that they almost invariably wish to introduce certain novel crops or kinds of live stock which generally can be more profitably produced in other districts. A certain degree of success may be attained by following a new type, but usually the greater success is scored by sticking to the enterprises which experience has shown can be carried on profitably in the area in question.

TOPOGRAPHY AND SOIL.

Often too little attention is given to the condition of the soil and the lay of the fields with reference to ease of cultivation. Crop land in itself is of little value unless it is so situated that it can be made to yield profitable returns through the use of labor and machinery. A farm of 160 acres, valued at $100 per acre, may be a much better bargain if practically all of the land can be put to some profitable use than another farm of 160 acres purchasable at $50 per acre, of which large areas are practically without utility owing to streams, swamps which can not be drained, or rough stony areas not suitable even for pasture.

In selecting a farm, therefore, it is essential that not the total area as conveyed by the deed or contract be considered, but the area available for profitable use. Any additional land may be really a liability instead of an asset, since very often the returns are not even sufficient to pay the taxes. A great many mistakes are made on this point alone, the buyer frequently thinking that he can crop the land in one way or another but later finding that conditions are such that it is more profitable to permit it to grow up to brush or woods than to attempt to cultivate it.

Another factor is ease of cultivation. If the land is very steep or broken it is not practicable to use improved machinery and it is even difficult to harvest the crops and remove them from the land by older methods. This is particularly true in loading hay and grain on steep hills. Smaller loads have to be drawn than on level land, and much time is wasted in loading. Such fields, of course, can be worked, but it must be remembered that the cost of producing crops on such land is necessarily higher than the cost of producing them on fields which permit of a more efficient use of labor and machinery. This difference in cost must be reflected in lower valuation, and hence in lower taxes and interest or rental charges; otherwise the farmer must pay these increased costs out of the returns from his own labor.

The physical condition of the soil is an important matter and one which should receive first attention, particularly from the beginner with small capital. Frequently, even on high-grade farms, soils get into very poor condition through a few years of mismanagement. It is a very easy matter to cause untold damage to good land through improper tillage or careless handling of the soil. To correct such damage usually takes several years. One should distinguish between those soils which are of a poor physical condition naturally and which can not easily be corrected by the use of manures and better methods of cultivation, and those which are in poor physical condition through improper management and which can be restored by good management. Putting a soil in prime condition for planting is a fine art, that can be fully learned only through long experience in handling the particular type of land involved.

The depth of the soil is of great importance and is a matter to which attention should be given when the land is first examined. Shallow soil is often a liability and its utility is sharply limited for practically all farming purposes. It is cold and wet in the spring, the water table being kept close to the surface. Later it dries out rapidly and becomes baked and hard. Such soil is quickly affected by drought. Shallowness is a common defect in a great many areas. Some fields may have a soil much more shallow than that in others. This shallowness may not necessarily be due to the hard rock being close to the top but to "hardpan," an impervious layer of clay, which is just as harmful as rock in shutting off drainage and preventing the plant roots from extending to their proper depth. This shallowness is a characteristic which is not easily distinguished. It can best be detected by the use of a soil auger. If shallowness of soil is general or characteristic of the region, it may be detected to a certain extent by the tree growth, certain kinds of trees being found on thin soils. An experienced farmer can usually detect it by the general type of plant growth, but an inexperienced person, particularly in a new region, may be badly mistaken on this point. It is one of importance and should be considered carefully.

Connected closely with thin soils is the subject of drainage. On this point a person selecting a farm should make assurance doubly sure, first, as to the natural drainage of the fields, and, second, as to the possibility of draining them if the land needs artificial drainage. There are few good soils that do not need artificial drainage in many places. The gains from ease in working the land, earlier drying out in the spring, and consequent lengthening of the time available for preparation for crops, the insurance of deep rooting of the plants and consequent protection from injury by drought, to say nothing of the gain through avoiding crop failures due to water standing on the land and slowness in drying, which often rots the seed or retards growth, are very important factors bearing on successful crop production. Thin soils and, in general, those which need drainage the most are usually difficult to drain, chiefly because they are not deep enough to allow the tile to be put far enough below the surface. The topography of many farms is also such that good drainage is impossible, because it is impossible to get a suitable outlet without going to a great deal of expense. Ease in digging ditches should also be considered wherever drainage is needed.

Again, many fields are wet during certain seasons of the year owing to what is known as "seepage"; that is, water being brought to the top by rock outcroppings or by strata of clay coming near the surface. Where this occurs on hillsides, or on generally rolling land, it is frequently very difficult to correct by drainage, as the rock or clay layers which bring the water to the surface run across the slope of the hill, and ditches to catch the water successfully would have to run along the side of the hill, those going up and down not catching the water unless they were placed very close together. This is a point which should be carefully watched for on many eastern farms, particularly in those regions where the soils are of glacial origin.

It is often difficult to determine merely by looking at the crop growing on it at certain seasons whether a field needs drainage. Frequently the best-appearing fields, even with considerable slope to them and seemingly well drained, as a matter of fact are very poorly drained in many ways. Ridges or level areas on the tops of hills or in rolling districts are often poorly drained, largely because of the thinness of the soil.

All of these factors, such as the amount of usable land, ease of cultivation, depth of drainage, condition of soil, freedom from danger of erosion, blowing, flooding, etc., should receive the closest attention, for they directly affect the productivity of the land and the returns which may be derived from it.

ARRANGEMENT OF FARM.

In choosing a farm one can seldom find the ideal arrangement of buildings and fields, and a farm which may be very desirable in many other particulars may be undesirable in this respect. In the Eastern States the buildings and fields were laid out and arranged in the days when labor was comparatively cheap and there was little thought of saving it. At present the saving of labor is a most important factor, and the arrangement of a farm may be such that much time is lost because of irregularity in the shape of fields, or because important fields are far from the buildings. The latter fault sometimes can not be remedied. In the Eastern States three factors have determined, more or less, the location of the buildings: (1) The water supply, (2) the roads, and (3) the area of good arable land nearby. In regions where spring water is generally used the buildings were invariably placed so that the water could be piped or carried to them. Thus water supply had a greater weight in determining the location of the buildings than ease of reaching the fields or the highway. It is not uncommon to find the best fields distant from the farm buildings, or to find the buildings far removed from the highway, which depreciates very materially the value of the farm.

Again, the arrangement of the buildings themselves, as regards ease in doing chores or other work about them, is important. Often the buildings were planned for one type of farming, and that having been discontinued and another taken up, they are not suited to the particular kind of farming now practiced. Frequently, however, alterations can be made which will improve the arrangement in many respects, but then, again, conditions may be such that this can not be done.

WATER SUPPLY.

The experienced farmer in selecting a farm will generally look first at the source and dependability of the water supply, because he knows that a farm without an adequate supply of water is most undesirable. Attention should be directed to the quality of the water, to the question of whether the supply is dependable at all seasons of the year, and to the cost of obtaining it.

The cost of upkeep and supply of water on a farm is often a big item. Except in regions where there is an abundant supply of spring water it usually costs more on a farm than in a city. If live-stock farming is carried on, special attention should be given to the dependability of the water during hot, dry months, and also during the winter months. It is difficult to obtain water from streams or to drive cattle long distances during severely cold weather. Water in the various pastures sufficient for the live stock is a valuable asset on any farm.

SOCIAL CONDITIONS.

The question of good schools is obviously important. Attention should be given not only to the accessibility of elementary schools and high schools, but also to the taxes required to keep up these schools. In the same way, churches and other institutions have an important bearing upon the desirability of the farm. The character of the people in the neighborhood, their interests and ideals are also important.

Very often an excellent farm is sold cheap because the owner does not care to live in a certain neighborhood. Disagreeable social features are not always apparent to the purchaser until some time after locating. Such conditions may not affect the productive possibilities of the farm, but do materially affect the home life and comfort of the farmer and his family, and in that way make the farm undesirable.

PROSPECTIVE RISE IN VALUE.

A very large number of farms are bought solely because the buyers believe that the land will rise in value and that they will be able to dispose of their holdings later at a substantial increase. In fact, many thousands of American farmers have made more substantial profits in this way than they have in farming. This practice is to be vigorously condemned in all cases where the buyer merely holds the land for speculative purposes. However, where farms are purchased with a view to developing and putting them in shape and then placing them on the market again, no valid objection can be raised.

An enormous rise in capital value of farm lands has taken place in this country during the last 20 years, and no one can predict with certainty the probable course of values in the future. The buyer of a farm, however, should carefully look into the development of the region in the past with a view to determining whether present values have been brought about by speculation in lands or whether they are attributable to the inherent good qualities of the land and the proximity to markets. He should also note those features which might affect its value in the future, such as the possibility of new railroads, of improvement of existing highways, of the development of near-by markets, of increase or decrease in demand for the particular products produced in that region, etc.

In considering the price of the particular farm selected, it is suggested that the prospective buyer make out a statement of the income as derived from the farm during the previous year. This financial statement of the farm under its present system of management is an excellent guide whereby to judge of its real worth and to indicate its possibilities for development. The blanks presented in Farmers' Bulletin 661, "A method of analyzing the farm business," are suitable to be followed.

Very often the occupant of a farm will not have a statement of the exact receipts and expenditures from the various crops and live stock, but this should not deter one from attempting to make out a financial statement of the farm business. The seller or agent, if he is in earnest about disposing of the property, should be willing to give or obtain a substantially correct statement of the business conducted.

Examine this statement as to the total receipts, especially the sources, the stability of each, and the possibilities of increase. Note whether the receipts are due to good crop yields or to exceptionally high prices for that particular year. Note especially the income from the live stock, as to whether the profit came from good gains, the production of milk, or from high prices received. See whether any by-products have been unused, or whether especial attention has been given to their sale or use.

Note the cost of labor, how many men it took to operate the farm, and at what period of the year. Note the amount of feed, such as hay or grain, that may have been purchased to carry the live stock; the expenditures for fertilizers; thrashing bill; and ginning or hay-baling expense. Note also the costs of repairs and upkeep; if these two items are unusually low, find out whether the owner has deferred necessary repairs in the expectation of disposing of his property. Note particularly the taxes and what they were for, whether for State, county, or local schools, and consider the possibility of increase or decrease in these taxes.

After examining this statement go over the farm with the idea of determining whether the income from any particular crop can be materially increased or whether new crops or better arrangement can be substituted, so as to bring about an increased revenue. Note any features which will make for a lessening of expenses, such as operating the farm with a smaller number of work stock, fewer workers, etc. Note particularly the improvements that must be made in the near future, such as new roof, flooring, sills, or framework construction for the barn; fencing, laying tile, etc.

BUYING EQUIPMENT, LIVE STOCK, ETC., WITH A FARM.

Often it is a distinct advantage when purchasing a farm to buy the equipment, live stock and materials already on the place. In this way an income is yielded almost from the outset, which usually makes possible the operation of the farm without a loss, and thus gives the new comer a chance to work out changes and plans and at the same time have a self-sustaining farm business.

If only the bare farm is purchased it usually takes some time to supply all the equipment and live stock and put the place on a paying basis. In the meantime overhead costs and other expenses amount to a considerable item. There is a distinct advantage in buying a farm that is a going concern.

POSSIBILITY OF DISPOSING OF FARM.

The statement has been made that all the farms in the country change ownership every 30 years. Many of these pass from father to son by inheritance, or otherwise change owners, but are kept in the family. On the other hand, a great many farmers dispose of their farms for one reason or another by sale, and when one is buying a farm he should also think about the time when he may want to sell it. It is sometimes a great deal easier to buy than it will be to sell.

If a farm can not be sold in some regions it can be rented, but in certain regions it is almost impossible to rent out a farm. This usually happens in areas of rather poor soils, where the farms are of low productive capacity and will not yield an income sufficient to give the owner a return on his investment and leave the tenant enough to induce him to operate the place.

Very large farms are often difficult to sell because only a small number of persons want unusually large farms as compared with the number who desire and are able to buy medium-sized farms.

BUYING A FARM AND RENTING ADDITIONAL LAND.

It is often possible to purchase a small area and then increase the size of the business by renting adjoining lands. This practice permits the farmer to operate a good-sized business with a limited capital and at the same time gives him greater security than if he had no property of his own and rented the entire business.

Such a practice is a stepping stone which many men use in changing from the status of the renter to that of the owner. It is a practice which can be followed only in regions where land is readily available for renting and where grain farming or general farming is followed. This practice would hardly be possible in dairying or other live-stock farming, where the production of roughage and other feeds for the herd was required. Some years certain lands might not be available for renting, and this would mean a decided reduction in the herd.

Again, this practice might be followed with the idea of eventually buying adjoining lands. This question, therefore, is one which should be looked into carefully before making the venture.

RENTING A FARM.

Much of the foregoing discussion in regard to purchasing a farm applies equally well to the selection of a farm for renting. However, a farm is usually rented more as a place of business than as a home, and in view of this special attention should be given to the question of size as related to efficiency of operation, the importance of good soil, and the sureness of a market for the crops. One must also bear in mind that in renting a farm it is presupposed that the income will be sufficient to give the landlord a return on his investment and the tenant an income for his labor and the use of his capital in equipment, live stock, etc. This means that the farm must have the basis of a good income in order to make a sufficient return for both parties interested.

Farm-management investigations have shown that the profits of the tenant are usually in direct proportion to the size of the business he operates. As a tenant usually furnishes the live stock and machinery, a good-sized business permits him to obtain the greatest efficiency with his capital and is a most important consideration from his standpoint. The soil must be such that the crops will not only pay for the labor and materials expended in their production but will also yield an income on the capital invested. It must, therefore, necessarily be of good quality. As said above, farms in regions of low fertility are seldom rented.

Again, the tenant, usually having but a small amount of capital, and being wholly dependent upon the year's work to give him his living, must guard against losses arising from a poor market or unfavorable climatic conditions.

SUMMARY.

As the purpose of this bulletin is merely to suggest some of the points which a person should observe when selecting a farm, the author has attempted to give only some of the more important of these.

A score card has been used sometimes to bring out the desirable and undesirable features of a farm. This is valuable only in giving a list of the items or points to be taken into consideration. It is not practicable to assign relative weights to any particular items. For instance, a farm might score perfect in every respect except water supply, but if no water was available it would be useless. Hence assigning to each item a percentage or weight might lead to erroneous conclusions. A better method seems to be to examine carefully all the features of two or more farms and then view the matter in a broad, common-sense way.

The appended blank form is presented as a summary of the points emphasized in this bulletin.

BLANK FORM FOR USE IN SELECTING A FARM.

Location of farm--

Owner --

Address --

Distance to shipping station---------------; to trading center---------------

Condition of roads------------; in winter------------; in spring------------

Distance to schools and churches------------; to nearest neighbor------------

Is telephone available?-------------------- R. F. D.?--------------------

Electric current for lighting------------------; for power------------------

Total area of farm----------; acres in crops----------; acres that can be used for crops------; acres in pasture------; acres in woods------; acres in waste land------; in roads, buildings, lots, swamps, lakes, etc.------; acres in stump or brush land------. Kind of timber----------; ease in getting out timber or wood--

Topography as regards economy of cultivation----------; irrigation----------; danger from erosion or sliding----------------; flooding----------------

Natural fertility as evidenced by kind of forest growth and native vegetation----------------
Present condition of fertility as evidenced by growth of crops or weeds--------
Physical condition of the soil-----------; adaptability to legumes-----------; adaptability to all kinds of crops----------------
Natural drainage-------- Artificial drainage-------- Depth of soil--------
Kind of surface soil---------------- Kind of subsoil----------------

Water supply: Source------------; quantity in dry summer months or during winter months--------; cost of upkeep--------; supply in pastures--------

Buildings as suited to kind of farming;------------; adaptability to another type of farming--------------; cost of upkeep------------; arrangement for economy of work----------; desirability of dwelling as a home----------; condition of fences------------; kind as regards cost of upkeep------------; farm highways------; shape of fields------; nearness to farmstead------

Kind of orchards----------------; condition----------------
Adequacy of trees for home use----------------

Climate: As to growing season----------------; days available for farm work----------------; healthfulness------------

Neighborhood: Character of people----------------; available labor supply----------------

Possibility of increase or decrease in value of land----------------
Possibility of selling farm----------------
Possibility of renting farm----------------
Desirability of farm as a strictly business investment----------------
Desirability of farm as a home or place to retire----------------
Adaptability of farm to changing economic conditions necessitating change of type----------------
Adaptability of farm for enlargement of business----------------
Adaptability of farm for diversification or improved organization of the business----------------
Adaptability of the farm for high yields of crops and desirability for livestock production----------------
Sureness of market for major crops grown----------------
History of farm as regards management of land with respect to keeping up fertility----------------
History of region as to development and speculation in lands as affecting present price----------------
Number of other well-developed farms in immediate vicinity which are successful--------------------. How long have they been farmed?------------
What are some of the operators' difficulties?----------------
How soon can the farm be made a going concern?----------------

SOURCES OF INFORMATION FOR PROSPECTIVE BUYERS OF FARMS.

SOIL SURVEYS.

Soil surveys have been made of many areas by the Bureau of Soils of the United States Department of Agriculture. The advance sheets of these soil surveys may be obtained through the Bureau of Soils of the United States Department of Agriculture as long as the supply available for free distribution lasts, the Department's edition being only 1,000 of each. Many of those no longer available for free distribution may be obtained for a nominal sum from the Superintendent of Documents, Government Printing Office, Washington, D. C. Persons interested in knowing what areas have been surveyed by the Bureau of Soils should request the Superintendent of Documents to send to them his Price List 46, entitled "Soils and Fertilizers."

IRRIGATION PROJECTS OF THE RECLAMATION SERVICE.

The irrigation projects developed by the Government of the United States are under the jurisdiction of the Reclamation Service, a branch of the Interior Department. Detailed information as to areas open to settlers may be obtained by addressing the statistician of the Reclamation Service, Washington, D. C.

HOMESTEADING PUBLIC LANDS.

Jurisdiction over the public lands of the United States which are open to homesteaders is in the General Land Office, a branch of the Interior Department. Detailed information as to areas open to homesteaders and the terms which must be complied with in order to obtain a homestead may be obtained by addressing the commissioner of the General Land Office, Washington, D. C.

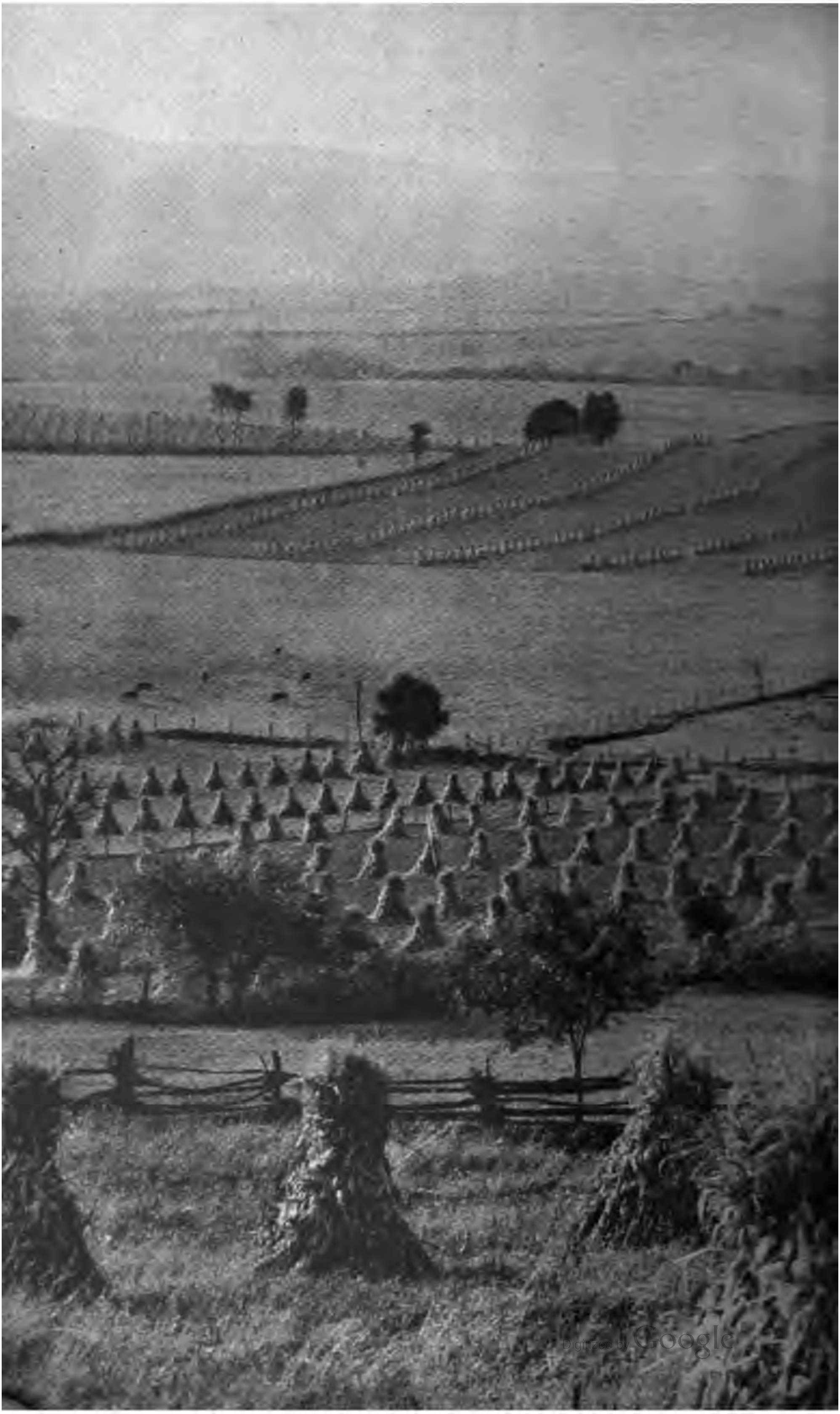
VARIOUS STATE AGENCIES.

Some of the States are making special efforts to assist the farmer or prospective farmer in making a proper location. California and South Dakota both have State land settlement boards, although the purposes of these boards are not identical. The director of immigration of the Wisconsin Department of Agriculture is, among other things, attempting to advise settlers who desire to locate on Wisconsin land. In a number of States lists of farms for sale or publications descriptive of agricultural conditions have been issued by the State Boards of Agriculture or by similar agencies. The Department of Farms and Markets of the State of New York, Albany, New York, has issued annually in recent years, "A List of Farms for Sale or Rent in New York." The agricultural experiment station of some States have issued bulletins or reports on soils. In other cases agricultural experiment stations have issued bulletins giving information of a general nature to prospective settlers.

Up-to-date references for a particular State on agricultural subjects or authorities can usually be secured by addressing the State officers in charge of agricultural extension work. These officers are located as follows:

ADDRESSES OF STATE OFFICERS IN CHARGE OF AGRICULTURAL EXTENSION WORK.

Alabama: Alabama Polytechnic Institute, Auburn.
Arizona: College of Agriculture, University of Arizona, Tucson.
Arkansas: College of Agriculture, University of Arkansas, Fayetteville.
California: College of Agriculture, University of California, Berkeley.
Colorado: State Agricultural College of Colorado, Fort Collins.
Connecticut: Connecticut Agricultural College, Storrs.
Delaware: Delaware College, Newark.
Florida: College of Agriculture, University of Florida, Gainesville.
Georgia: Georgia State College of Agriculture, Athens.
Idaho: The State House, Boise.
Illinois: College of Agriculture, University of Illinois, Urbana.
Indiana: Purdue University, Lafayette.
Iowa: Iowa State College of Agriculture and Mechanic Arts, Ames.
Kansas: Kansas State Agricultural College, Manhattan.
Kentucky: College of Agriculture, University of Kentucky, Lexington.
Louisiana: Louisiana State University and Agricultural and Mechanical College, University Station, Baton Rouge.
Maine: College of Agriculture, University of Maine, Orono.
Maryland: Maryland State College of Agriculture, College Park.
Massachusetts: Massachusetts Agricutural College, Amherst.
Michigan: Michigan Agricultural College, East Lansing.
Minnesota: Department of Agriculture, University of Minnesota, University Farm, St. Paul.
Mississippi: Mississippi Agricultural and Mechanical College, Agricultural College.
Missouri: College of Agriculture, University of Missouri, Columbia.
Montana: Montana State College of Agriculture and Mechanical Arts, Bozeman.
Nebraska: College of Agriculture, University of Nebraska, Lincoln.
Nevada: College of Agriculture, University of Nevada, Reno.
New Hampshire: New Hampshire College of Agriculture and the Mechanic Arts, Durham.
New Jersey: College of Agriculture and Mechanic Arts of Rutgers College and the State University of New Jersey, New Brunswick.
New Mexico: New Mexico College of Agriculture and Mechanical Arts, State College.
New York: New York State College of Agriculture, Ithaca.
North Carolina: North Carolina State College of Agriculture and Engineering, West Raleigh.
North Dakota: North Dakota Agricultural College, Agricultural College.
Ohio: College of Agriculture, Ohio State University, Columbus.
Oklahoma: Oklahoma Agricultural and Mechanical College, Stillwater.
Oregon: Oregon Agricultural College, Corvallis.
Pennsyvania: Pennsylvania State College, State College.
Rhode Island: Rhode Island State College, Kingston.
South Carolina: Clemson Agricultural College of South Carolina, Clemson College.
South Dakota: South Dakota State College, Brookings.
Tennessee: College of Agriculture, University of Tennessee, Knoxville.
Texas: Agricultural and Mechanical College of Texas, College Station.
Utah: Agricultural College of Utah, Logan.
Vermont: University of Vermont and State Agricultural College, Burlington.
Virginia: Virginia Polytechnic Institute, Blacksburg.
Washington: State College of Washington, Pullman.
West Virginia: College of Agriculture, West Virginia University, Morgantown.
Wisconsin: College of Agriculture, University of Wisconsin, Madison.
Wyoming: College of Agriculture, University of Wyoming, Laramie.



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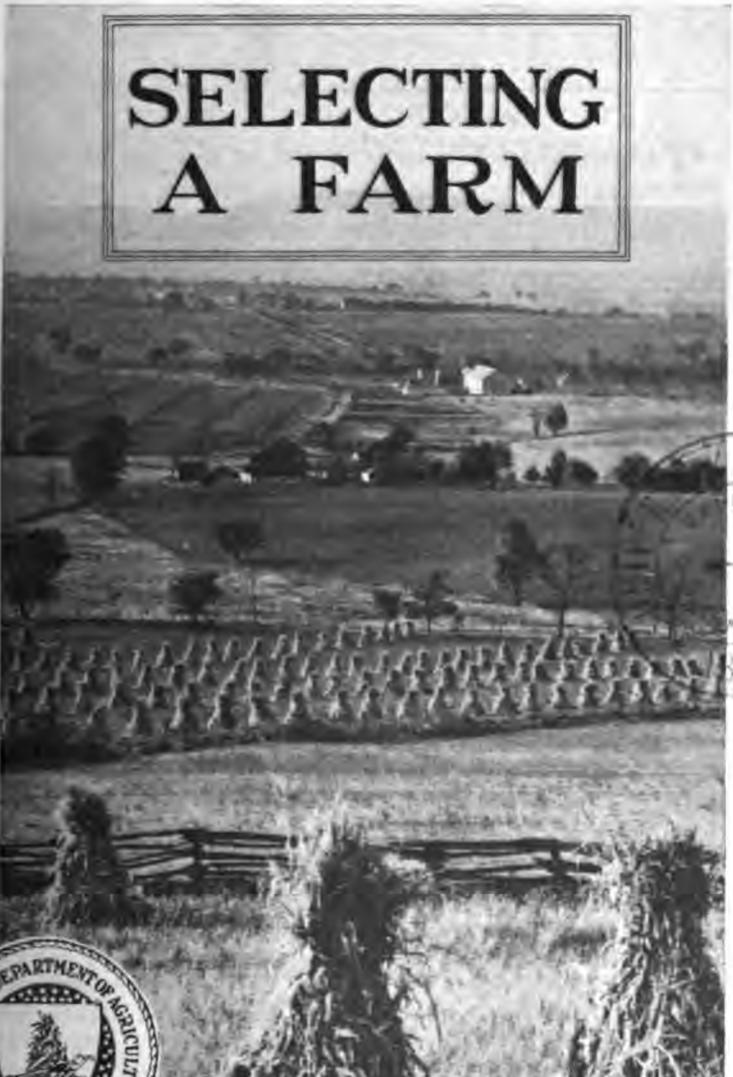
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1088

SELECTING A FARM



VIRGINIA

THIS BULLETIN is designed to aid the prospective buyer or renter in the choice of a farm. It is written for those who already have had some experience in farming, rather than for the inexperienced, and is intended primarily to offer suggestions to the farmer whose training has been rather limited, or to the more experienced man who contemplates moving to an unfamiliar locality or changing to an unfamiliar type of farming. It is assumed that no one wholly without experience in farming would be so rash as to choose a farm on the strength of knowledge gleaned merely from a bulletin on the subject.

Washington, D. C.

Issued March 1926
Revised March 1935

SELECTING A FARM

By E. H. THOMSON, formerly *Assistant Chief, Office of Farm Management*[1]

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WISE SELECTION of a farm is vital to the success and satisfaction of farm life. Choosing a farm often means choosing a place in which to live and work for a lifetime. It is important to decide wisely in buying for investment, but in making a selection for a home it is of double importance that the various features that may have a decisive bearing on the farm business or that may affect the home life be considered. It is the purpose of this bulletin to bring some of these points to the reader's attention so that he may be in a position to view the matter on all sides and weigh the advantages and disadvantages before buying or renting a particular farm.

It has been said that we are creatures of environment. If this is true of any class of people, it is true of farmers. The farm boy travels in his father's footsteps, all too often without attempting to gain a broader point of view through acquaintance with conditions other than those that have shaped his father's life. The conservatism of the farmer is primarily based on the fact that generally he is a student of none but local conditions. When a person has been trained in only one kind of farming he is likely to look at another kind of farm business with prejudice. The dairyman can see only dairying. He thinks in terms of cows, acres of silage corn, and tons of hay. A fruit farmer can see nothing but fruit, and habitually thinks in terms of the fruit business.

Many farmers, especially the younger men, in moving from one region to another, make serious errors in their selections of farms, not that their judgment is naturally poor, but mainly because they know only one set of conditions and are not able to measure accurately all the factors that must be taken into account in choosing the new location. It is here that the science of farm management is helpful, for from the farm-management viewpoint the farm is put on a business basis, so that all the influences which may have a bearing on the profitableness of this business are considered.

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[1] The Office of Farm Management, later the Office of Farm Management and Farm Economics, was merged, in 1922, with the Bureau of Markets and Crop Estimates to form the present Bureau of Agricultural Economics.

But in doing this the home side of the question must always be kept in mind. The farm home and the farm business are inseparable. A desirable farm, from a business standpoint, is nevertheless undesirable if it has no social or community advantages. On the other hand, desirable living conditions are of little or no advantage unless supplemented by a successful farm business.

A farm may have fine buildings, good water supply, splendid roads, and other assets of this nature, yet if the soil is rocky, shallow, or naturally infertile, so that its productive possibilities are distinctly limited, there will be no adequate income wherewith to enjoy the other advantages. Moreover, these physical limitations are enduring while the needed improvements, such as buildings and roads, can be added as means are provided.

It is fully realized that many persons select certain regions or certain farms largely for personal reasons. In such instances the personal factor outweighs all others, and the question of the desirability of the farm from a business standpoint is comparatively of less importance.

Few farms possess all of the desirable features, and it is often sound business to invest in a farm or in land even though it has certain undesirable features. Naturally, the particular circumstances and the purposes for which the individual wants a farm will always be taken into consideration in making a selection.

TRAINING AND EXPERIENCE

It is assumed at the outset that the prospective farm buyer or renter has sufficient training and experience along agricultural lines to justify him in making the venture. Successful farming is not easy. It requires much experience in doing the various kinds of farm work and the ability to show others how to do this work. It requires training in business management and knowledge of the principles of plant growth, the feeding and care of animals, and the maintenance of soil fertility. Few industries require such a wide range of training and experience. Farming is not simply growing a particular crop or feeding a certain kind of livestock. It is an all-the-year-round business, involving the production of various plants and animals and the successful organization of the varying farm enterprises into a smoothly working unit.

For a man to obtain the needed training and experience on his own farm is usually expensive. It is much cheaper for the beginner to get the preliminary training by working for another farmer. A successful farmer, in speaking of his farming experience, has said:

> If anyone could have told me at the outset the things I have had to learn through 50 years of management of this farm, years of experiment would have been saved and success made very much easier.

The suggestions outlined in this bulletin are primarily for the beginner and the less-experienced person; nevertheless it is assumed that no one entirely unfamiliar with agriculture would presume to buy a farm after merely reading a book or bulletin on the subject.

In buying a farm a city man should bear in mind that he is in much the same position in choosing a home and business in the country as the farmer would be if he went to a city to buy a home and place of business. Lack of experience and information in either case is usually expensive. Many of the finer points that an experienced farmer would note in inspecting a farm cannot be discussed here. The experienced farmer, when choosing a farm of a familiar type, does not need a score card in making his selection.

TO BUY OR TO RENT?

In choosing a farm there are the following options: (1) Buying a farm with the intention of operating it as one's entire business; (2) buying a small farm and renting enough additional land to meet one's needs; (3) renting a farm either on a share or cash basis.

The question of whether to buy or rent cannot definitely be answered here, but the suggestions as to the benefits derived from the use of capital and size of the farm business apply in either case. The choice in this matter is usually determined by the funds available.

If one has only a small amount of capital and wishes to undertake farming as a business from which to derive his entire income, he should, in nearly all cases, begin as a renter. But if he wishes to buy a farm on which to live, deriving a part of his income from other sources, then probably purchasing is desirable, even though capital is limited.

Again in many cases if a small farm can be bought, it is possible to develop this as a basis of operations and to rent additional land in the neighborhood. This is not an altogether desirable method of operation; it is never certain that suitable lands will be available. But it is an expedient that enables one to operate a much larger business than he could otherwise with the amount of capital he has, and at the same time have a home that he can call his own.

Whatever course is followed, it is highly desirable that the basic business principles governing the farm business be thoroughly understood before some of the finer points are decided. A disregard of these basic principles is responsible for a large percentage of farm failures. A man may unconsciously work all his life against some unsuspected economic barrier, when success would have been comparatively easy had he selected a farm where economic forces would aid him instead of working against him.

THREE VITALLY IMPORTANT FACTORS

To achieve success in an ordinary farming venture it is almost essential to have these three advantages:

(1) Opportunity for a paying size or volume of business, (2) a quality of crop land and of livestock productive enough to be profitable except under most adverse economic conditions, and (3) suitable conditions, both as to natural resources and environment and as to markets, to permit the development of a dependable organization of fairly diversified activities.

ADEQUATE SIZE OF BUSINESS

Other things being the same, the net income from a farm is directly affected by the size of the business. If the gross income is small the net income must necessarily be relatively small, no matter how economical the management. In earlier years the amount of hand labor available largely controlled the size of the farm business, but under present conditions the determining factor is not what a man actually can accomplish with his own hands, but what he can accomplish with the aid of power, machinery, and other agencies.

Land, buildings, and equipment are economically valuable only insofar as they can be used for productive purposes. The real income from a farm is derived from three sources—returns for the use of land, returns from working capital, and returns for labor expended. If both capital investment and labor expended are small, the income must necessarily be small. Capital working alone in the farm business will not yield an income; a man may have plenty of land to work, but if he does not work it he gets nothing. Then again, if he has but a small acreage, or an acreage that gives but limited opportunity for profitable work he necessarily is limited in income from his labor. It is possible, of course, to conduct a large business on a small acreage, but intensive farming, such as market gardening, can be carried on only with a great expenditure of man labor. The man who chooses to farm an acreage too small to permit the free use of labor-saving implements, should understand that a convenient market for his products and a relatively large application of manual labor per acre are essential to even a moderate success (fig. 1).

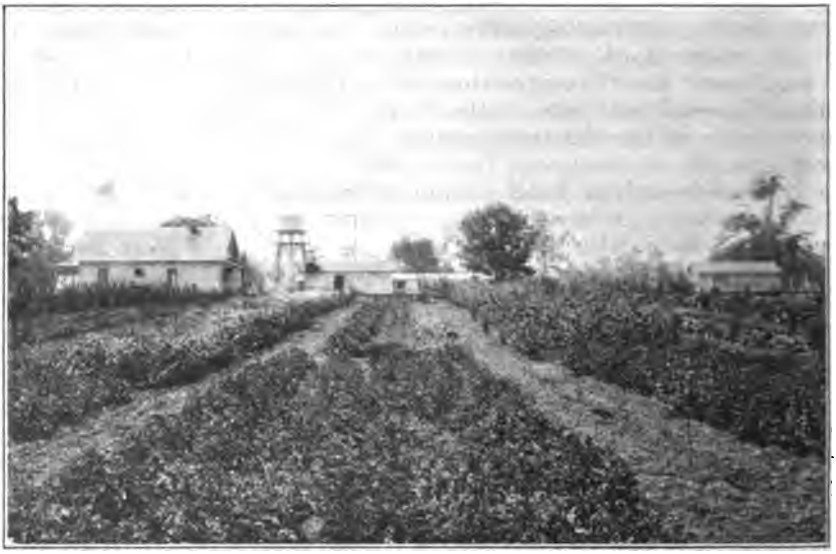

FIGURE 1.—This kind of farming necessitates a great expenditure of hand labor.

It should be borne in mind that it requires a farm business of considerable size to provide an income that will even cover maintenance charges, and that these charges are relatively larger for small farms than for large farms. A farm may be of such a size as to furnish most of the supplies needed in the farmer's living, such as garden and fruit, and enough income to pay the taxes and running expenses, but unless there is a margin above this annual maintenance charge no progress can be made toward accumulating a surplus.

This point is often overlooked, and thousands of men fail to understand why they do not get ahead faster, when, as a matter of fact, the size of their business is such that there is only a remote possibility of any margin being left after obtaining a bare living and paying absolutely necessary running expenses. Often the income is not enough even to do this, and the farmer and his family have to go without some of the comforts of life.

Thus it is that the size of the farm business is one of the most important factors to be considered in selection. In evaluating a farm in this regard it is essential to make sure of three things: (1) That you have an opportunity. That is, make sure that the desired volume of business is at least potentially there, as evidenced by tillable land or by markets for intensive crops on small areas, (2) that the volume of business can be achieved by economical methods, and (3) that the volume of business that can be conducted on the farm is such that, if prices are normal, it will yield an income large enough to provide a comfortable margin, after paying the absolutely necessary expenses of operation and providing an adequate living for the farmer and his family, for saving or future demands.

The watchword should be "opportunity", and opportunity hangs upon two factors, either of which is of no avail without the other: (1) Room to use capital and labor economically and (2) a place to market the harvest.

On the other hand, it is possible to get farms that are too large. One important advantage of a farm no larger than can be handled by the farmer and his family is that such farms can be operated with a minimum of cash outlay, whereas larger farms require a higher percentage of their operating costs to be actually paid in cash. This situation is dangerous in periods of low prices for farm products. Most of the extremely large farms that were in existence at the beginning of the present depression have succumbed to a situation in which the out-of-pocket costs exceeded the cash income.

The present widespread unemployment in American industry has had the effect not only of stopping the usual flow of farm population into the cities but of actually inducing a return movement to the farm. This has substantially increased the demand for farms; and, if the conditions that have induced the situation remain, smaller sized farms and more intensive cultivation of them may be one of the results. However, those who are contemplating buying a small farm for the purpose of making a living should beware of getting an area too small to provide an opportunity to grow sufficient products to insure at least a gross income adequate from the point of view of the needs of the family.

HIGH QUALITY OF BUSINESS

It is obviously essential to the success of any farm to grow crops and to keep livestock that return enough to pay more than the cost of production. On a certain farm at one time it took 32 bushels of corn to cover the bare cost of growing the crop. When the farmer harvested 33 bushels he had a margin of but 1 bushel over and above the cost. On a farm across the road it took 34 bushels to pay the cost of growing the corn, but the farmer harvested 50 bushels—a margin of profit 16 times that of his neighbor. Such margins represent the difference between success and failure.

In choosing a farm be sure to see that the prospects are for crop yields more than enough to balance the cost of their production. It is plain common sense that good crops are better than poor crops and that good cattle are better than poor cattle. Soils of low fertility are a handicap; in fact, some soils are a positive liability if they must be farmed. It is well to inquire thoroughly into yields, not only those that have been obtained on the farm itself for a series of years, but those realized on nearby farms. Learn whether poor crops are due to poor soil or to bad management. If yields are very high, inquire carefully as to how they are obtained, and judge for yourself as to the economy of the methods used. If the yields have been very low, it may be that the better management or improved methods which may be put into effect will make possible the production of profitable crops; but before buying in such a case, make doubly sure that the land is capable of improvement.

Equally essential to the success of the farm business is high quality of the livestock enterprise; that is, handling livestock so that they will pay for feed, care, and labor. This is more than a matter of management, for it is dependent on cheap roughage, on pasturage, on a market, and on getting labor at reasonable rates.

The quality of the business must not be confused with the question of prices for which the products are sold. A man may be growing excellent crops or have very fine livestock, but the prices he receives may be so low as to make even high yields and good livestock unprofitable. More often, however, failure in the farm business is occasioned by low yields and poor livestock when the products are marketed at prevailing prices. The chances of success are with the man who grows a good crop and keeps at least a fair quality of livestock.

ADEQUATE DIVERSIFICATION OF FARM BUSINESS

Diversification of the farm business, as represented by the production of several salable products, lessens the risk of loss from crop failure and low prices, promotes better utilization of teams, labor, and machinery, permits rotation of crops, and on the whole is conducive to the safety and stability of the farm business.

If the farm selected is so situated that it is desirable to grow only one product, be very certain as to the reliability of that product, both as to production and as to sale. If the climate is such that only a limited class of crops will thrive or mature, the growing season may be so short that certain crops essential to a good rotation cannot be grown. Make doubly sure that climatic conditions, such as rainfall, period of drought, late spring or early fall frosts, hailstorms, strong winds, hot winds, fogs, and humidity do not seriously limit the development of a diversified farm business. It is generally possible to grow some crops, but can all those needed be grown so successfully as to insure a well-balanced farm organization? Many farmers have failed through failing to give proper attention to this question.

Equally important with market and climatic limitations are soil and topography. A soil may grow beans, corn, oats, and timothy, but not clover—an essential crop for many rotations. The soil may be too sandy for some crops. It may blow badly or wash when intertilled crops are used in the rotation. It may be too poor, or it may be subject to leaching, or alkali, or drought. These conditions may not necessarily limit all the crops, yet may be so unfavorable as to limit certain crops on which proper diversification of the business must be built.

AMOUNT OF CAPITAL

The outlay of capital in the farm business is generally a question not of how much to invest in the business but of how much of a farm business can be undertaken with the funds and credit available. In the case of those having plenty of capital, the amount needed to finance the business is governed by the size of the farm they may choose to operate.

It is important to bear in mind the necessity for a proper distribution of capital among the items of land, equipment, livestock, supplies, and cash for operating expenses. A poorly balanced equipment, in point of livestock, machinery, or other features, may seriously limit the farm income. Lack of enough horses to do the work, or of the necessary livestock to consume the hay or roughage is a serious handicap, particularly for a beginner. On the other hand, investment in expensive items of machinery or improvements may well be postponed for a few years, the primary object at the beginning being to equip the farm with those things which will count from the outset toward the making of an adequate net income. Later, as profits are made, other improvements can be added. Overinvestment in buildings is a common fault of beginners and not uncommon among farmers in general. Expensive buildings entail a heavy annual charge against the business. (Figs. 2 and 3.)

The proportion of the total investment in land and in the various items of equipment should vary according to the price of the land and the kind of farming followed. In a general or diversified farming business (that is, growing staple crops, with dairy cows, hogs, or other cattle) from 70 to 80 percent of the total farm investment will be required by the land and buildings. On truck, fruit, grain, and cotton farms, possibly 90 percent may be represented by real estate. The amount of cash necessary for running expenses will vary from 1 to 3 percent of the total investment. This will depend largely on the way the annual income from the farm is received. On dairy farms the checks from milk or cream are received every month or more frequently. These furnish funds for running expenses and a smaller amount of cash is needed for operating expenses.

The successful farmer, however, usually keeps funds at hand to use for bargains should occasion arise. Cattle may be going at a low price at a neighborhood auction or the farmer may have a chance to buy second-hand machinery to replace that worn out. Many farmers buy much of their equipment in this way. The amount invested in machinery, tools, etc., will usually range from 2 to 5 percent of the total farm investment. The remainder of the funds will be represented by livestock, feed, and supplies, the amount of the

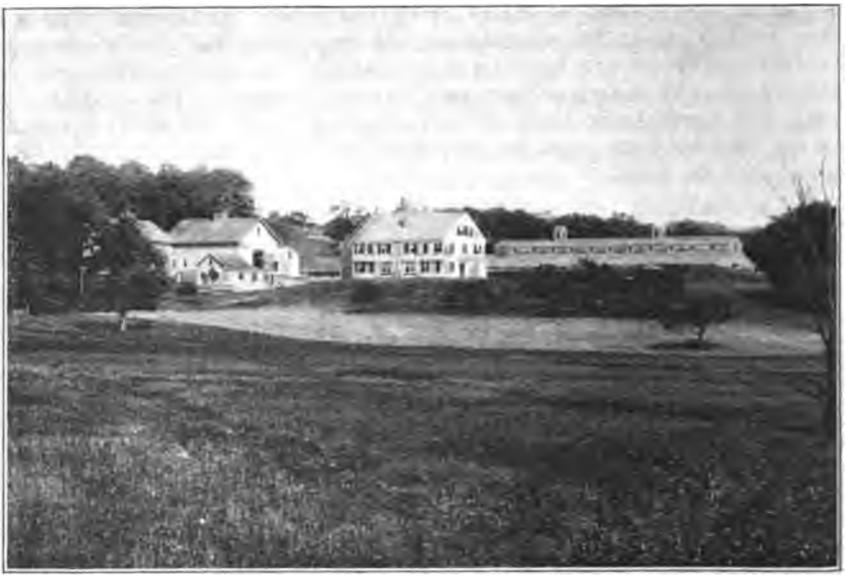

FIGURE 2.—A "show farm" on which overhead expenses were so great that the business lost money.

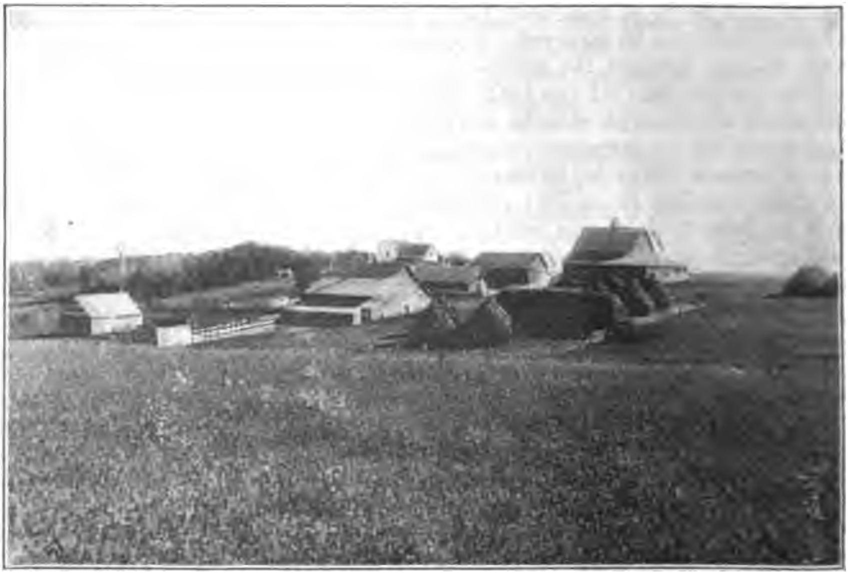

FIGURE 3.—Farmstead of a successful Corn Belt farm. Buildings are ample for the large business but are not expensive.

latter depending largely upon the season of the year and the number and kind of livestock kept.

With limited capital it is a common practice to buy as large a farm as possible with the amount available to cover the cash payment required at the time of purchase and still have enough funds to equip and operate the farm selected. Thus, if the buyer had $5,000 in cash he might invest his funds somewhat as follows: He selects a farm costing $8,500, of which $6,000 could remain as a first mortgage. Thus he places $2,500 in land as a cash payment at time of purchase, giving a mortgage for $6,000. This leaves $2,500 for equipment and operating expenses. He might put $600 in machinery and tools, $1,200 in work stock and other livestock, $300 in feed and supplies, and $400 in cash to carry on the business. These are only approximate figures and will vary considerably according to the farm selected.

Usually for a beginner in the farm business the amount in cash should exceed that ordinarily used by a farmer in a well-established business, as more funds are needed in getting started than later when the business is well established.

Only a rough approximation can be given of the number of work stock necessary. On general farms having more than 100 acres in crops there should be one work horse for every 20 to 25 acres of crops; on eastern farms having 50 acres or under in crops one horse to every 12 to 15 acres of crops, and on cotton farms one mule to every 12 to 16 acres of cotton plus 8 to 10 acres of corn and other crops. As the size of the farm increases up to a certain point, greater efficiency of work stock and machinery is obtained, and each work horse or machine works a larger area. Observation as to the number of horses needed on neighboring farms of the same size is an excellent guide in this matter.

Farm-management investigations have shown conclusively that there is a marked increase in efficiency in the use of men, horses, and machines on medium-sized farms over small farms. Why this is true is obvious when we stop to analyze the problem. If your horses work only 15 acres of crops each and the horses of your neighbor across the road work 20 each, and you both sell your products to the same market, you necessarily have to bear a higher expense for horse labor. If your mowing machine cuts 25 acres a year and stands in the shed 360 days out of the year, and your neighbor's machine cuts 75 acres, your machinery charge per acre of hay cut must necessarily be higher than his.

Even on small farms occasions are constantly arising when at least two men are needed. One may be required to keep the team busy while the other goes to town for supplies or does the chores. Many operations can be done to advantage only with two men. One man in a general farm business, without help, can hardly work enough land fully to utilize his teams and machinery to the best advantage.

So far as investigations on this subject have progressed, no marked increase in efficiency of men, horses, and machines is obtained on very large farms over medium-sized farms. Stated differently, there is a pronounced increase in efficiency on a medium-sized farm over a small farm, but beyond a 2-man farm, or one on which from 20 to

25 acres of crops are covered per horse, there is no substantial gain in efficiency of men or teams by reason of larger acreage.

The tractor has come to be an important source of farm power. In most types of farming characterized by grain-crop growing, the tractor has increased the amount of land one man can handle by making possible the use of larger tillage and harvesting machinery than is feasible with horse power. This has tended to increase the usual size of farm in areas where tractor power has become dominant.

The typical American farm, generally speaking, provides work for the farmer and one additional worker. In many cases the additional help is the farmer's son or some other member of his family.

ADAPTABILITY TO CHANGING ECONOMIC CONDITIONS

In choosing a farm, it is well to bear in mind the probable effect of changing economic conditions. Certain crops may cease to be profitable, owing to the development of other regions more favorably situated for their production and marketing. Some crops may have to be abandoned because of disease or insect pests. The question should be asked: Is the farm selected adapted to such possible changes?

For instance, suppose the farm selected is now growing beans, potatoes, corn, oats, clover, and hay, with the prospect that beans and potatoes will soon cease to be profitable. Can some other crop or crops be found to replace them? Few regions have a wide range of crops, especially in general farming, and adaptability to new crops is an important consideration.

Can the beef-cattle farm be made over into a dairy farm? Can the dairy farm be made into a sheep farm? Can the fruit farm be made into a hay, grain, or livestock farm? In many instances it will be found that the farm in question demands an inflexible type of farming that cannot be changed to meet changing conditions.

The history of American agriculture is filled with thousands of illustrations of agricultural evolution brought about by the great development of agriculture in the movement of settlement from East to West. Many of the greatest mistakes of the present generation have been made in this particular. Men have selected farms that were all right at the time, but in a few years, with changed market conditions, their whole business has been ruined, leaving them with farms on their hands which did not admit of reorganization or readjustment. Such failure may result from having too small an area for general farming, or from having soil not adapted to the production of staple crops. The Eastern States are strewn with run-down farms which were profitable under the conditions of a generation or two ago, but which cannot be adapted to present-day conditions with respect to labor, use of machinery, and transportation. This is one of the important factors responsible for the low price of land in some of our Eastern States.

The West also has made serious mistakes in the same way, even within the last few decades (fig. 4). Many farms, selected with a view to some special type of farming, are found to be too small to be efficient or profitable when a more stable or diversified business becomes necessary.

This mistake is made both by experienced and by inexperienced farmers. Experienced farmers make the error when the change is to a new type of farming, such as when a grain farmer goes into fruit growing or a small back-yard poultry grower goes into a large poultry business.

While making a selection, look back and follow the local economic changes that have occurred in the last 30 years and then judge for yourself whether the farm you have under consideration has the adaptability necessary for meeting the changes that are bound to come in the future.

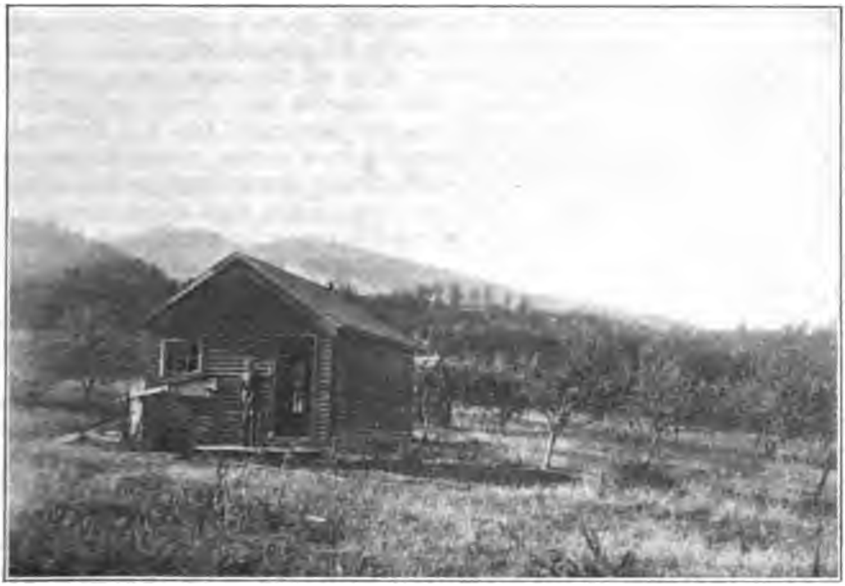

FIGURE 4.—A deserted orchard farm in the Northwest. The owner of this place failed because of poor soil and lack of adequate irrigation.

CAN A HIGH QUALITY OF FARM BUSINESS BE MAINTAINED?

A point that needs special emphasis is the capacity of the farm for the maintenance of a high quality of business, as evidenced by good crop yields, good pastures, and feed for livestock.

The yields may be satisfactory at the outset, but when the soil is broken and cultivated, are conditions such that these yields can be maintained? Often the soil is soon exhausted because most of the humus is on the surface. Again, the land may soon become sour or alkali from poor drainage. Many soils, when cleared of timber and broken up, deteriorate rapidly even under good management. Their fertility is only on the surface, and they are easily and quickly impoverished.

In livestock farming an important factor is plenty of cheap roughage. A farm that permits of the production of such feeds, for instance a place with good pastures, is more desirable and is likely to have a greater range of adaptability than one that lacks this important advantage. An inexperienced person should be especially cautious and be careful not to select land which, under good management, cannot be kept in a productive state.

LOCATION

The choice of a farm as to climate and kind of farming to be followed is largely a personal matter. One may prefer the kind of farming that is carried on in a Northern State, another may like the climate of a Southern State. Again, a man may have personal reasons for taking up dairy farming, or fruit farming, or some other type. It is not possible to outline here the advantages and disadvantages or points to look out for in each type of farming that may be found in different parts of the country. If a man has a preference for a particular type of farming, as a general proposition he should go where that type is well developed, which fact is an indication that conditions are favorable for it. Embarking on an entirely new type of farming in a region where it has not been heretofore followed is an exceedingly hazardous undertaking. Sometimes it is successful, but the chances are that there are some very good reasons why such a type of farming is not found in that region. However, a man who is intensely interested in a special type of farming might make a success of it in a comparatively unfavorable region, through great care and skilled management, whereas others, who were not so experienced in this kind of an undertaking, would fail.

City persons who take up farming for the first time, almost invariably wish to introduce certain novel crops or kinds of livestock which generally can be more profitably produced in other districts. This is a common mistake. A certain degree of success may be attained by following a new type, but usually the greater success is scored by sticking to the enterprises which experience has shown can be carried on profitably in the area in question.

TOPOGRAPHY AND SOIL

Often too little attention is given to the condition of the soil and the lay of the fields with reference to ease of cultivation. Crop land in itself is of little value unless it is so situated that it can be made to yield profitable returns through the use of labor and machinery. A farm of 160 acres, valued at $100 per acre, may be a much better bargain if practically all of the land can be put to some profitable use than another farm of 160 acres purchasable at $50 per acre, of which large areas are practically without utility owing to streams, swamps which cannot be drained, or rough stony areas not suitable even for pasture.

In selecting a farm, therefore, it is essential that not only the total area as conveyed by the deed or contract be considered, but also the area available for profitable use. Any additional land may be really a liability instead of an asset, since very often the returns are not even sufficient to pay the taxes. A great many mistakes are made on this point alone, the buyer frequently thinking that he can crop the land in one way or another but later finding that conditions are such that it is more profitable to permit the land to grow up to brush or woods than to attempt to cultivate it.

Another factor is ease of cultivation. If the land is very steep or broken it is not practicable to use improved machinery, and it is even difficult to harvest the crops and remove them from the land by older methods. This is particularly true in loading hay and grain on steep hills. Smaller loads have to be drawn than on level land, and much time is wasted in loading. Such fields can be worked, but it must be remembered that the cost of producing crops on such land is necessarily higher than the cost of producing them on fields which permit a more efficient use of labor and machinery. This difference in cost must be reflected in lower valuation, and hence in lower taxes and interest or rental charges; otherwise the farmer must pay these increased costs out of the returns from his own labor.

The physical condition of the soil is an important matter and one which should receive first attention, particularly from the beginner who has small capital. Frequently, even on high-grade farms, soils get into very poor condition through a few years of mismanagement. It is an easy matter to cause untold damage to good land through improper tillage or careless handling of the soil. To correct such damage usually takes several years. One should distinguish between those soils which are of a poor physical condition naturally and which cannot easily be corrected by the use of manures and better methods of cultivation, and those which are in poor physical condition through improper management and which can be restored by good management. Putting a soil in prime condition for planting is an art that can be fully learned only through long experience in handling the particular type of land involved.

The depth of the soil is of great importance and is a matter to which attention should be given when the land is first examined. Shallow soil is often a liability, and its utility is sharply limited for practically all farming purposes. It is cold and wet in the spring, the water table being kept close to the surface. Later it dries out rapidly and becomes baked and hard. Such soil is quickly affected by drought. Shallowness is a common defect in a great many areas. Some fields may have a soil much more shallow than that of others. This shallowness is not necessarily due to hard rock being close to the top but may be due to hardpan, an impervious layer of clay which is just as harmful as rock in shutting off drainage and preventing the plant roots from extending to their proper depth. This shallowness is a characteristic that is not easily distinguished. It can best be detected by the use of a soil auger. If shallowness of soil is general or characteristic of the region, it may be detected to a certain extent by the tree growth, certain kinds of trees being found on thin soils. An experienced farmer can usually detect it by the general type of plant growth, but an inexperienced person, particularly in a new region, may be bady mistaken on this point. It is important and should be considered carefully.

Connected closely with thin soils is the subject of drainage. On this point a person selecting a farm should make sure, (1) as to the natural drainage of the fields, and (2) as to the possibility of draining them if the land needs artificial drainage. There are few good soils in the humid regions of the country that do not need artificial drainage in many places. The gains from ease in working the land, earlier drying out in the spring, and consequent lengthening of the time available for preparation for crops, the insurance of deep rooting of the plants and consequent protection from injury by drought, to say nothing of the gain through avoiding crop failures due to water standing on the land and slowness in drying, which often rots the seed or retards growth, are important factors bearing on successful crop production. Thin soils and, in general, those that need drainage most are usually difficult to drain, chiefly because they are not deep enough to allow the tile to be put far enough below the surface. The topography of many farms is also such that good drainage is impossible, because it is impossible to get a suitable outlet without going to great expense. Ease in digging ditches should be considered wherever drainage is needed.

Again, many fields are wet during certain seasons of the year owing to what is known as seepage; that is, water being brought to the top by rock outcroppings or by strata of clay coming near the surface. Where this occurs on hillsides, or on generally rolling land, it is frequently very difficult to correct by drainage, as the rock or clay layers which bring the water to the surface run across the slope of the hill, and ditches to catch the water successfully would have to run along the side of the hill, those going up and down not catching the water unless placed very close together. This is a point which should be carefully watched for on many eastern farms, particularly in those regions where the soils are of glacial origin.

It is often difficult to determine merely by looking at the crop growing on it at certain seasons whether a field needs drainage. Frequently the best-appearing fields, even with considerable slope to them and seemingly well drained, as a matter of fact are very poorly drained in many ways. Ridges or level areas on the tops of hills or in rolling districts are often poorly drained, largely because of the thinness of the soil.

Another physical factor which should be watched in the selection of a farm is the effect of erosion. Many fields have been severely damaged through this physical process. It manifests itself in two ways. It develops gullies that cut up the fields, making them inconvenient for farming and forming channels through which large amounts of fertility are carried off. The other form of erosion is sheet erosion. A small or large proportion of the topsoil may be removed by rainfall or wind, although no gullies develop. It is not easy to detect this type in a superficial examination.

Farm lands in the different parts of the country vary greatly in their susceptibility to erosion and in the extent to which erosion damage has actually gone. In general, the erosion damage is considerably higher in certain areas in the South than in the North. This is partly because the land is exposed to erosive influences for a longer season in the South and partly because the system of farming is not tied up so closely with livestock as in the North, where the use of pasture and other nonerosive crops that protect the soil are more frequent.

All of these factors, such as the amount of usable land, ease of cultivation, depth of drainage, condition of soil, freedom from danger of erosion, blowing, and flooding, should receive the closest attention, for they directly affect the productivity of the land and the returns that may be derived from it.

ARRANGEMENT OF FARM

In choosing a farm the ideal arrangement of buildings and fields can seldom be found, and a farm that may be very desirable in many other particulars may be undesirable in this respect. The arrangement may be such that much time is lost because of irregularity in the shape of fields, or because important fields are far from the buildings. The latter fault sometimes cannot be remedied. In the Eastern States three factors have determined, more or less, the location of the buildings: (1) The water supply, (2) the roads, and (3) the area of good arable land nearby. In regions where spring water is generally used the buildings were placed so that the water could be piped or carried to them. Thus water supply had a greater weight in determining the location of the buildings than ease of reaching the fields or the highway. It is not uncommon to find the best fields distant from the farm buildings, or to find the buildings far removed from the highway, which materially depreciates the value of the farm.

Again, the arrangement of the buildings themselves, as regards ease in doing chores or other work about them, is important. Often the buildings were planned for one type of farming, and that having been discontinued and another taken up, they are not suited to the kind of farming now practiced. Frequently alterations can be made which will improve the arrangement in many respects, but then, again, conditions may be such that this cannot be done.

WATER SUPPLY

The experienced farmer in selecting a farm will generally look first at the source and dependability of the water supply, because he knows that a farm without an adequate supply of water is most undesirable. Attention should be directed to the quality of the water, to the question of whether the supply is dependable at all seasons, and to the cost of obtaining it.

The cost of upkeep and supply of water on a farm is often a big item. Except in regions where there is an abundant supply of spring water, it usually costs more on a farm than in a city. If livestock farming is carried on, special attention should be given to the dependability of the water during hot, dry months, and during the winter months. It is difficult to obtain water from streams or to drive cattle long distances during severely cold weather. Water in the various pastures sufficient for the livestock is a valuable asset on any farm.

SOCIAL CONDITIONS

The question of good schools is important. Attention should be given not only to the accessibility of elementary schools and high schools, but also to the taxes required to keep up these schools. In the same way, churches and other institutions have an important bearing upon the desirability of the farm. The character of the people in the neighborhood and their interests and ideals, are also important.

Often an excellent farm is sold cheap because the owner does not care to live in the neighborhood. Disagreeable social features are not always apparent to the purchaser until some time after locating. Such conditions may not affect the productive possibilities of the farm, but do materially affect the home life and comfort of the farmer and his family, and in that way make the farm undesirable.

CHANGES IN FARM-LAND VALUE

In the period 1900 to 1920 many farms were bought primarily in the hope of profiting by the increase in value. This was a period of rapid rise in the value of land, and many people, including farmers, made substantial gains through buying and holding land. At the end of this period both land and commodity prices fell abruptly. Those who bought land near the close of the boom period lost heavily.

There is now a question as to whether it is wise to buy land when it is needed to start a farming business, or for expanding one already in operation. There is great uncertainty about the future prices of agricultural products and about the whole agricultural situation. The man who is contemplating buying a farm should consider carefully the quality of the land and its situation with reference to the prospective market for the products it is best fitted to produce. American agriculture must continue to feed the American population, buying land for speculation is always hazardous. However, the low levels to which land values have sunk may offer an excellent opportunity for buying land for farming purposes.

In considering the price of the particular farm selected, it is suggested that the prospective buyer make out a statement of the income as derived from the farm during the previous year. This financial statement of the farm under its present system of management is an excellent guide whereby to judge of its real worth and to indicate its possibilities for development. The blanks presented in Farmers' Bulletin 1139, A Method of Analyzing the Farm Business, are suitable for use.

Often the occupant of a farm will not have a statement of the exact receipts and expenditures from the various crops and livestock. but this should not deter the prospective buyer from attempting to make out a financial statement of the farm business. The seller or agent, if he is in earnest about disposing of the property, should be willing to give or obtain a substantially correct statement of the business conducted.

Examine this statement as to the total receipts, especially the sources, the stability of each, and the possibilities of increase. Note whether the receipts are due to good crop yields or to exceptionally high prices for that particular year. Note especially the income from the livestock, as to whether the profit came from good gains or the production of milk, or from high prices received. See whether any byproducts have been unused, or whether especial attention has been given to their sale or use.

Note the cost of labor, how many men it took to operate the farm, and at what period of the year. Note the quantity of feed such as hay or grain that may have been bought to carry the livestock, the expenditures for fertilizers, threshing bill, and the ginning or hay-baling expense. Note the costs of repairs and upkeep; if these two items are unusually low, find out whether the owner has deferred necessary repairs in the expectation of selling his property. Note particularly the taxes and what they were for—whether for State, county, or local schools—and consider the possibility of increase or decrease in these taxes.

After examining this statement go over the farm with the idea of determining whether the income from any particular crop can be materially increased or whether new crops or better arrangement can be substituted, so as to bring about an increased revenue. Note any features that will make for a lessening of expenses, such as operating the farm with a smaller number of work stock or fewer workers. Note particularly the improvements that must be made in the near future, such as new roof, flooring, sills, or framework construction for the barn, fencing or laying tile.

BUYING EQUIPMENT AND LIVESTOCK WITH A FARM

Often it is a distinct advantage when purchasing a farm to buy the equipment, livestock, and materials already on the place. In this way an income is yielded almost from the outset, which usually makes possible the operation of the farm without a loss, and thus gives the newcomer a chance to work out changes and plans and at the same time have a self-sustaining farm business.

If only the bare farm is bought it usually takes some time to supply all the equipment and livestock and put the place on a paying basis. In the meantime overhead costs and other expenses amount to a considerable item. There is a distinct advantage in buying a farm that is a going concern.

POSSIBILITY OF DISPOSING OF FARM

The statement has been made that all the farms in the country change ownership every 30 years. Many of these pass from father to son by inheritance, or otherwise change owners, but are kept in the family. On the other hand, a great many farmers dispose of their farms for one reason or another by sale, and when one is buying a farm he should also think about the time when he may want to sell it. It is sometimes a great deal easier to buy than it will be to sell.

Very large farms are often difficult to sell because only a few persons want unusually large farms as compared with the number who wish and are able to buy medium-sized farms.

BUYING A FARM AND RENTING ADDITIONAL LAND

It is often possible to buy a small area and then increase the size of the business by renting adjoining lands. This practice permits the farmer to operate a good-sized business with a limited capital and at the same time gives him greater security than if he had no property of his own and rented the entire business.

Such a practice is a stepping stone which many men use in changing from the status of the renter to that of the owner. It is a practice that can be followed only in regions where land is readily available for renting and where grain farming or general farming is followed.

This practice would hardly be possible in dairying or other livestock farming, where the production of roughage and other feeds for the herd is required. Some years certain lands might not be available for renting, and this would mean a decided reduction in the herd.

Again, this practice might be followed with the idea of eventually buying adjoining lands. This question, therefore, is one which should be looked into carefully before making the venture.

RENTING A FARM

Much of the foregoing discussion in regard to buying a farm applies equally well to the selection of a farm for renting. However, since a farm is usually rented more as a place of business than as a home, special attention should be given to the question of size as related to efficiency of operation, the importance of good soil, and the sureness of a market for the crops. It must also be borne in mind that in renting a farm it is presupposed that the income will be enough to give the landlord a return on his investment and the tenant an income for his labor and the use of his capital in equipment, livestock, and materials. This means that the farm must have the basis of a good income in order to make a sufficient return for both parties interested.

As a tenant usually furnishes the livestock and machinery, a fair-sized business permits him to obtain the greatest efficiency with his capital and is a most important consideration from this standpoint. The soil must be such that the crops will not only pay for the labor and materials expended in their production but will also yield an income on the capital invested. It must, therefore, necessarily be of good quality. As said above, farms in regions of low fertility are seldom rented.

Again, the tenant, usually having but a small amount of capital and being wholly dependent upon the year's work to give him his living, must guard against losses arising from a poor market or unfavorable climatic conditions.

SUMMARIZING POINTS

As the purpose of this bulletin is merely to suggest some of the points a person should observe when selecting a farm, only some of the more important of these points have been covered.

A score card has been used sometimes to bring out the desirable and undesirable features of a farm. This is valuable only in giving a list of the items or points to be taken into consideration. It is not practicable to assign relative weights to any particular items. For instance, a farm might score perfect in every respect except water supply, but if no water was available it would be useless. Hence assigning to each item a percentage or weight might lead to erroneous conclusions. A better method seems to be to examine carefully all the features of two or more farms and then view the matter in a broad, common-sense way.

The following blank form is presented as a summary of the points emphasized in this bulletin.

BLANK FORM FOR USE IN SELECTING A FARM

Location of farm________
Owner ________
Address ________
Distance to shipping station________; to trading center________
Condition of roads________; in winter________; in spring________
Distance to schools and churches________; to nearest neighbor________
Is telephone available?________ R. F. D.?________
Electric current for lighting________; for power________
Total area of farm________; acres in crops________; acres that can be used for crops________; acres in pasture________; acres in woods________; acres in waste land________; in roads, building, lots, swamps, lakes, etc________; acres in stump or brush land________. Kind of timber________; ease in getting out timber or wood________
Topography as regards economy of cultivation________; irrigation________; danger from erosion or sliding________; flooding________
Natural fertility as evidenced by kind of forest growth and native vegetation ________
Present condition of fertility as evidenced by growth of crops or weeds________
Physical condition of the soil; adaptability to legumes________; adaptability to all kinds of crops________
Natural drainage________. Artificial drainage________. Depth of soil________ Kind of surface soil________. Kind of subsoil________
Water supply: Source________; quantity in dry summer months or during winter months________; cost of upkeep________; supply in pastures________
Buildings as suited to kind of farming________; adaptability to another type of farming________; cost of unkeep________; arrangement for economy of work________; desirability of dwelling as a home________; condition of fences________; kind as regards cost of upkeep________; farm highways________; shape of fields________; nearness to farmstead________
Kind of orchards________; condition________
Adequacy of trees for home use________
Climate: As to growing season________; days available for farm work________; healthfulness________
Neighborhood: Character of people________; available labor supply________
Possibility of increase or decrease in value of land________
Possibility of selling farm________
Possibility of renting farm________
Desirability of farm as a strictly business investment________
Desirability of farm as a home or place to retire________
Adaptability of farm to changing economic conditions necessitating change of type________
Adaptability of farm for enlargement of business________
Adaptability of farm for diversification or improved organization of the business________
Adaptability of the farm for high yields of crops and desirability for live-stock production________
Sureness of market for major crops grown________
History of farm as regards management of land with respect to keeping up fertility________
History of region as to development and speculation in lands as affecting present price________
Number of other well-developed farms in immedate vicinity that are successful________. How long have they been farmed?________
What are some of the operators' difficulties?________
How soon can this farm be made a going concern?________
Are taxes on this farm reasonable?________
Can the present owner transfer a sound title?________

SOURCES OF INFORMATION FOR PROSPECTIVE BUYERS OF FARMS

SOIL SURVEY

Soil surveys have been made of many areas by the Bureau of Chemistry and Soils of the United States Department of Agriculture. These soil-survey reports may be obtained through that Bureau as long as the supply available for free distribution lasts, or from one of the Senators or the Representative in Congress from the district in which the farm is located. Many of those no longer available for free distribution can be obtained for a nominal sum from the Superintendent of Documents, Government Printing Office, Washington, D. C. Persons interested in knowing what areas have been surveyed by the Bureau of Chemistry and Soils should request the Superintendent of Documents to send to them his Price List 46, entitled "Agricultural Chemistry and Soils and Fertilizers."

IRRIGATION PROJECTS OF THE RECLAMATION SERVICE

The irrigation projects developed by the Government of the United States are under the jurisdiction of the Reclamation Service, a branch of the Interior Department. Detailed information as to areas open to settlers may be obtained by addressing the Bureau of Reclamation, United States Department of the Interior, Washington, D. C.

VARIOUS STATE AGENCIES

Some of the States are making special efforts to assist the farmer or prospective farmer in making a proper location. The director of immigration of the Wisconsin Department of Agriculture is attempting, among other things, to advise settlers who wish to locate on Wisconsin land. The Department of Agriculture and Markets of the State of New York, at Albany, is undertaking to furnish information to those interested, in reference to the climatic, agricultural, and marketing conditions in the various sections of the State, and the adaptability of these areas to the various types of agriculture. It does not publish a list of farms for sale. Assistance to prospective settlers upon New York farms is given mainly through the medium of personal interviews. In a number of States lists of farms for sale or publications descriptive of agricultural conditions have been issued by the State boards of agriculture or by similar agencies. In some States the agricultural experiment station has issued bulletins or reports on soils. In other cases agricultural experiment stations have issued bulletins giving information of a general nature to prospective settlers.

Up-to-date references for a particular State on agricultural subjects or authorities can usually be obtained by addressing the State officers in charge of agricultural extension work. The following list shows where these officers are located.

ADDRESSES OF STATE OFFICERS IN CHARGE OF AGRICULTURAL EXTENSION WORK

Alabama: Alabama Polytechnic Institute, Auburn.
Arizona: College of Agriculture, University of Arizona, Tucson.
Arkansas: College of Agriculture, University of Arkansas, Fayetteville.
California: College of Agriculture, University of California, Berkeley.
Colorado: State Agricultural College of Colorado, Fort Collins.
Connecticut: Connecticut Agricultural College, Storrs.
Delaware: Delaware College, Newark.
Florida: College of Agriculture, University of Florida, Gainesville.
Georgia: Georgia State College of Agriculture, Athens.
Idaho: The State House, Boise.
Illinois: College of Agriculture, University of Illinois, Urbana.
Indiana: Purdue University, Lafayette.
Iowa: Iowa State College of Agriculture and Mechanic Arts, Ames.
Kansas: Kansas State Agricultural College, Manhattan.
Kentucky: College of Agriculture, University of Kentucky, Lexington.
Louisiana: Louisiana State University and Agricultural and Mechanical College, University Station, Baton Rouge.
Maine: College of Agriculture, University of Maine, Orono.
Maryland: Maryland State College of Agriculture, College Park.
Massachusetts: Massachusetts Agricultural College, Amherst.
Michigan: Michigan Agricultural College, East Lansing.
Minnesota: Department of Agriculture, University of Minnesota, University Farm, St. Paul.
Mississippi: Mississippi Agricultural and Mechanical College, Agricultural College.
Missouri: College of Agriculture, University of Missouri, Columbia.
Montana: Montana State College of Agriculture and Mechanical Arts, Bozeman.
Nebraska: College of Agriculture, University of Nebraska, Lincoln.
Nevada: College of Agriculture, University of Nevada, Reno.
New Hampshire: New Hampshire College of Agriculture and the Mechanic Arts, Durham.
New Jersey: College of Agriculture and Mechanic Arts of Rutgers College and the State University of New Jersey, New Brunswick.
New Mexico: New Mexico College of Agriculture and Mechanical Arts, State College.
New York: New York State College of Agriculture, Ithaca.
North Carolina: North Carolina State College of Agriculture and Engineering, West Raleigh.
North Dakota: North Dakota Agricultural College, Agricultural College.
Ohio: College of Agriculture, Ohio State University, Columbus.
Oklahoma: Oklahoma Agricultural and Mechanical College, Stillwater.
Oregon: Oregon Agricultural College, Corvallis.
Pennsylvania: Pennsylvania State College, State College.
Rhode Island: Rhode Island State College, Kingston.
South Carolina: Clemson Agricultural College of South Carolina, Clemson College.
South Dakota: South Dakota State College, Brookings.
Tennessee: College of Agriculture, University of Tennessee, Knoxville.
Texas: Agricultural and Mechanical College of Texas, College Station.
Utah: Agricultural College of Utah, Logan.
Vermont: University of Vermont and State Agricultural College, Burlington.
Virginia: Virginia Polytechnic Institute, Blacksburg.
Washington: State College of Washington, Pullman.
West Virginia: College of Agriculture, West Virginia University, Morgantown.
Wisconsin: College of Agriculture, University of Wisconsin, Madison.
Wyoming: College of Agriculture, University of Wyoming, Laramie.

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U. S. GOVERNMENT PRINTING OFFICE: 1935

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

A1. 9: 1089

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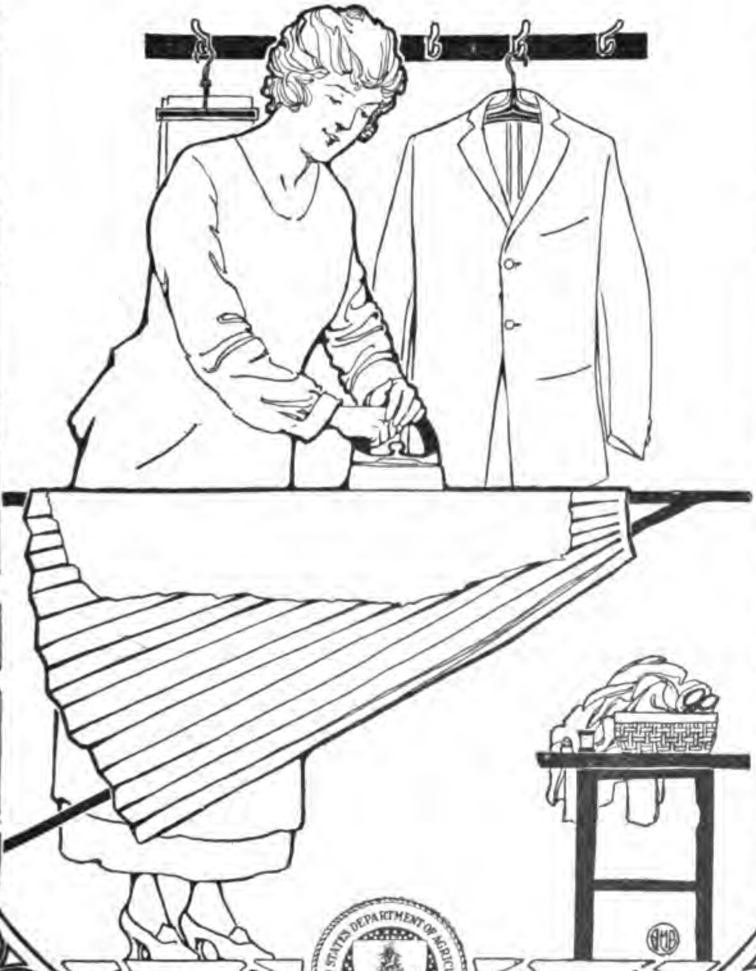
FARMERS BULLETIN 1089
UNITED STATES DEPARTMENT OF AGRICULTURE

SELECTION AND CARE OF CLOTHING



THE COST OF CLOTHING has been rising rapidly; therefore more than ever we need to know how to choose and use our garments wisely.

This bulletin gives practical suggestions as to how to select clothing that will be both attractive and durable and how to care for it so that it will render full service.

Contribution from the States Relations Service
A. C. TRUE, Director
Washington, D. C. February, 1920

SELECTION AND CARE OF CLOTHING.

LAURA I. BALDT,
Instructor, Department of Textiles and Clothing, Teachers College, Columbia University.

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THRIFT IN SELECTION AND CARE OF CLOTHING.

UNTIL RECENTLY many Americans did not seriously practice thrift in the selection and care of their clothing, some because they had never thought about it, some because they did not know simple ways to do it, some because they felt that to be thrifty about clothing meant wearing coarse undergarments and unattractive outer clothing.

Conditions during the last few years have been forcing people to look at the question from a different point of view. Prices have risen so high that unless the income has increased in proportion, it is a serious problem how to dress as well as the standard demands without spending more money than can be afforded. During the war the shortage of materials and labor caused patriotic citizens to buy as little new clothing as possible. The interest that this aroused in selecting and utilizing the wardrobe to the best possible advantage did not cease with the fighting.

Wise spending for clothing, as for everything else, does not mean going without what we need or can legitimately afford. It means deciding definitely what we really want and how much we ought to pay for it, and then trying to procure it as economically as possible and to get from it the maximum of service.

Clothing should always be comfortable and healthful; it must protect the body from cold, heat, moisture, and rough surfaces, according to need, and must allow freedom in all bodily movements. Its lines should be in harmony with or improve the lines of the figure;

it should produce a favorable impression of the wearer's individuality, and be suitable to the occasion upon which it is worn. The clothing problem for the individual or the family is how best to obtain this result with the money and the time that can be spent.

It is sometimes assumed that men and boys do not need to understand the details of the clothing problem, but the normal man or boy is just as much concerned with presenting a good appearance as his mother, wife, or sister. He chooses at least part of his clothing, and may even himself have the responsibility of keeping it in order. Boys as well as girls should therefore be taught how to select and care for their wardrobes.

A SPENDING PLAN FOR CLOTHING.

The systematic handling of expenses is an essential of thrift, in personal and family affairs as well as in the conduct of business. The person who does the family buying should know how the portion of the income devoted to household and personal needs is being spent and whether just returns are obtained from the expenditures. The first thing to do is to make a spending plan, or budget, and in it to set down the amounts to be devoted to rent, food, clothing, and the other items of expenditure. The part of the budget considered here is the apportionment for clothing (underclothing, outer clothing, accessories, and necessary care, repairs, and cleaning).

The total allowance for clothing will depend upon the amount of the income and the business and social demands upon individuals in the family. The average allowance for a family is between one-sixth and one-fourth of the income. The apportionment of this allowance among the members of the family will vary from time to time according to their needs. Of the total clothing allowance 70 per cent might be needed for outer clothing, such as coats, suits, dresses, shoes, etc., and 20 per cent for underclothing, while 5 per cent might be allowed for accessories, and 5 per cent for cleaning and repairs.

It is best to make such a budget for a period of at least a year, and some persons prefer to make clothing budgets for two or three years, because certain articles, such as raincoats, topcoats, and furs, may not be purchased oftener than that.

In making a budget, it is helpful to estimate how much money was used the year before for the different items of expenditure. If no accounts have been kept, this can be done roughly from memory or from back bills and check stubs. Persons who use budgets soon know the cost of the different items, and after a few years of record keeping do not need to work out everything on paper. In fact, the point of using a budget is to find where the income should and actually does go, and whether this information is in the head, in a book, or on filing cards is of minor importance.

TAKING STOCK OF LEFT-OVER CLOTHING.

The next step in planning a wardrobe is to take stock of all the clothing on hand, all that was left over from the last season as well as that which is in present use. It is often worth while to make an inventory. The work of doing this is greatly simplified if at the end of each season, when garments and other articles of clothing are being put away, they are listed, together with a short account of the condition of each, its possibilities for further usefulness, and an estimate of the approximate cost of the cleaning, pressing, repairing, or remodeling necessary to make it ready for use. These estimates should include not only the money that would be paid for repairs made by dressmakers, tailors, and other professional workers, but also the time that members of the family might spend upon such work. Such time is just as truly an element of the cost of clothing as if it were paid for, and should be considered on that basis. These lists may conveniently be kept in a record book, on filing cards, or on sheets of paper or cards left in the boxes, drawers, or cupboards where the garments are stored.

With the aid of such a list, much planning can be done before the garments are actually handled. They should, however, be looked over carefully before deciding what new clothing must be bought, for some articles may not prove to be so usable as they seemed when put away.

FRESHENING AND REMAKING OLD GARMENTS.

Generally, little can be done to undergarments except to patch or darn worn places, to sew on buttons, or perhaps to rework frayed buttonholes. Sometimes unworn parts may be recut into garments for smaller persons or children, but in such cases one must be sure that the amount of wear in the made-over garment will pay for the labor expended. Drawers and undervests can be made for children from the good parts of cotton or woolen undergarments that the adult can no longer use; also the tops of stockings can be converted into various garments. Good commercial patterns are to be had for such remodeling.

There are far greater possibilities for extending the service of the outer clothing than the underclothing. Women's dresses may often be freshened and made to look new, simply by cleansing, pressing, and adding new collars, cuffs, and girdles. If this does not seem practical, they may be recut for a smaller person, or the material may be combined with some other to make a garment. Two dresses, for instance a woolen and a silk or satin one, may often be combined to make one dress.

Women's coats may sometimes be made to look new and more attractive by adding collars and cuffs of velvet or fur for winter and of silk or satin for spring. New buttons, reworked buttonholes, and new or well-mended linings give an air of freshness. It may be better economy to recut the coat for a smaller person and use the amount thus saved toward the purchase of a new one.

A man's overcoat too badly worn for his further use may be recut to make a good overcoat for a boy; or a man's suit may be cut and made into an entire suit (jacket, trousers, and cap) for a small boy, the price of the boy's suit being saved toward that of a new one for the man. Men's shirts, the materials of which are strong enough to stand further wear, afford many possibilities for making over, but one must be very sure that the strength of the material will warrant the expenditure of time and labor. Children's dresses, rompers, little boys' suits, blouses, aprons for little and big, shirt waists for women, dustcaps, and laundry bags are some of the many things that may be made from shirts. (Figs. 1 and 2.)

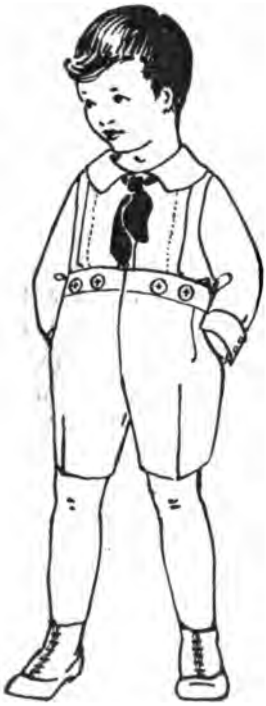

FIG. 1.—"Oliver Twist" suit for small boy. Trousers and possibly cuffs and collar made of material contrasting with waist. A good design for making over from larger garments.

Men's hats may be freshened by reblocking and renewing the ribbon and the sweat band. Panama hats (both men's and women's) can be cleaned and if necessary reblocked, and made to do service year after year. Some other kinds of straw hats will stand reblocking, but this is often expensive and not practicable unless the hat is made of good braid. Slightly soiled straw hats may sometimes be cleaned at home by scrubbing with lemon juice and rinsing with clear cold water. In doing this and in drying the hat afterwards great care must be taken not to change the shape. This can be accomplished, for example, by stuffing the crown with tissue paper or by pressing a flat brim against a table top. If vigorous scrubbing is necessary or if the shape needs changing, it is better to have the hat cleaned and reblocked by a professional worker.

Colored straw hats may be steamed, brushed, or wiped with a cloth moistened with alcohol to remove all dust, or if they are faded, they may be recolored by one of the commercial solutions. White or yellow straw hats may be cleaned and bleached unless too badly sunburned, in which case they can be colored. The braid on women's hand-sewed hats can often be ripped and freshened, and sewed on a new shape. This will not pay, however, unless the braid is of very good quality.

Brushing and steaming velvet, silk, or satin hats will help to restore their freshness. If a crown on a hat is badly worn and the brim is in good condition, a new crown may be made of net on a wire frame, or of silk or satin draped over a shape of crinoline or willow. An old shape that is in good condition may be re-covered.

All trimmings (feathers, ribbons, flowers, and others) from women's and children's hats that are not too badly worn or faded for later use should be brushed and put away in a special box when the hats are discarded; in such a "piece box" may often be found the very "bit" needed for freshening last year's hat. Ostrich feathers may be recurled by drawing each flue over the back of a knife or over a special feather curler. Ribbons if soiled can be freshened by steaming and pressing. Tissue paper should be laid over them while pressing to prevent them from becoming shiny, or they may be washed and stretched to dry on an unvarnished board or table or on a marble slab. Flowers that are faded, but not crushed, can be made to look fairly new by retinting with water colors and trimming the edges of the petals. New trimmings may be made of bits of silk, velvet, or wool; the silk or velvet may be shaped into flowers or fruit, and the wool crocheted into flower shapes or embroidered in geometric designs on bands or on the hat itself.

FIG. 2.—Boy's overalls. May be made from larger garments.

Articles of no further service should be disposed of promptly, for some of them may be used to advantage by local charities, by relief organizations, or perhaps by individuals. If one has the leisure, a kindly thing to do is to put such articles into usable condition; or by a bit of personal self-denial one might pay for the repair of shoes, coats, or other garments for some less prosperous person.

LISTING NEW GARMENTS NEEDED.

After stock has been taken of the left-over clothing, a list should be made of the new garments that will be needed by each member of the family for the coming season. Care must be taken not to list unnecessary apparel; as far as possible garments should be selected that will be suitable for different occasions yet will combine well with those garments already in use. If one can afford two suits or dresses and wear them alternately, they will both give longer service and the wearer will have a far greater sense of satisfaction because of not becoming tired of either. When the list is complete, the amount that can be spent for each garment should be apportioned to it. To these figures should be added the amount allowed for repairs and renovation. If the total exceeds the amount apportioned for clothing, the list should be gone over again, costs reduced where possible, and unnecessary items cut out, so that the sum is within the limit of the allowance. Better still, a margin should be left to provide for any unforeseen contingency, such as a mishap to a suit or the need for some special article of apparel, such as oftentimes arises when an unusual social event takes place or one is suddenly called away on a business trip.

CHOOSING CLOTHING.

With the list of needed garments carefully made out, it becomes an individual problem to decide how much of the clothing shall be bought ready-made, made to order, or made at home.

Ready-made clothing is often the easiest to obtain and has the advantage of showing the effect of the finished garment. It is of course more satisfactory for average figures than for those that differ decidedly from the normal. A certain amount of refitting can be done, but if the wearer's figure is much out of average proportions, the effect of the design is likely to be lost in the changes. It is generally considered that, for the same amount expended, garments made at home (especially undergarments) are usually of a better grade of material and workmanship, and therefore give longer service than those purchased ready-made. Made-to-order garments are costly, because they bear in addition to the price of the materials and the labor a percentage of the rental and other overhead expenses of the maker, to whom these items all cost more per garment than in the case of factory-made goods. On the other hand, the workmanship in good custom-made garments should be better than in ready-made ones, and for irregular figures the fit is usually more satisfactory.

The busy home-maker in many cases does not find the time to make all the clothing for her family, nor should all the time that she is free from other household duties be spent with needle and thread in hand, working under pressure to finish some needed garment. She must decide just how much time she may wisely spend on household sewing, and how far she can relieve herself by the purchase of ready-made or made-to-order clothing, and she must remember that her time has economic value even if it is not paid for in money. The business or professional woman often has little time for sewing other than her mending; moreover she has not always had the opportunity to acquire the technical skill that renders garment construction an enjoyable task. She should, however, always be awake to the necessity of clothing herself suitably and becomingly, and should give enough time to planning her wardrobe to make her clothing expenditure with thrift and wisdom.

Every one who buys clothing needs some knowledge of textiles, as a basis for judging materials in regard to their durability (strength, firmness, fastness of color), the quality of the fiber in relation to the cost, and the suitability of different materials to the needs of the wearer. Also knowledge of the prices and widths of materials and of the processes of garment making will help in calculating quantities of materials necessary and approximate costs, and is useful in judging the value of ready-made garments. Some understanding of the principles of clothing design will aid in selecting garments that will be becoming to the wearer and suitable to the occasion upon which they will be worn.

GENERAL FACTS ABOUT TEXTILES.

Textile study becomes interesting as its practical use becomes known. For instance, everyone knows that woolen garments shrink more than cotton when they are washed, that a piece of linen which looks very fine when it is bought may prove to be thin and loosely woven after the starchy dressing is washed out, or that a silk dress or coat lining may suddenly become full of holes. If the reasons for these things are known, clothing may be selected more wisely and may perhaps prove less costly in the end.

Wool shrinks more than cotton because each wool fiber is covered with scales, which open and interlock when subjected to moisture and changes of temperature but do not go back to their original state when dried. Care in washing will prevent undue shrinkage. Cotton, being smoother and not so absorbent as wool, can not shrink so much. The piece of linen that looked so good when new was probably filled with sizing to cover up the loose weave of the cloth. The silk went to pieces before it had rendered a reasonable amount of service because it had been so heavily weighted with mineral salts during dyeing that the silk threads were soon cut by the metal deposit.

In the process of manufacture, there are many ways of treating fibers to change their character or of substituting one kind for another, all of which are legitimate provided the material is sold for what it is. When it becomes possible to standardize the quality and price of materials as the manufacture of food has been regulated by pure-food laws, it will not be necessary to exercise so much care in purchasing materials as is now the case. A few suggestions regarding fibers and how to judge them are given here.

Cotton is rarely adulterated, but materials made of cotton are in many cases sized, that is, covered with a solution of glue, starch, or clay, which fills in the spaces between the threads and makes the material, until it is washed, seem finer and better than it really is.

Cotton yarn is often mercerized by treating it with chemicals and drying it under tension, a process that gives it a high luster and renders it smooth and strong. Mercerized cotton is excellent for many purposes; it is only when it is passed off as silk or linen at the price of these that the buyer should make objection.

Cotton is often mixed with linen, especially in towelings, which have a cotton warp and linen filling. Mercerized cotton is often used to adulterate linen, the luster making it difficult to detect the difference. These mixtures are not undesirable, especially now that pure linen is scarce, but they should be sold for what they are, not as pure linen.

The quantity of wool now produced would not permit all the woolen goods needed to be made of pure new wool; therefore it is necessary to resort to some methods of substitution. *The two most common substitutes for pure new wool are cotton and shoddy.* The use of cotton for the adulteration of wool is of advantage in the case of flannels and other wash materials, as it lessens shrinkage. When used in dress materials in limited proportions, it is not unsatisfactory and provides a less expensive material for many uses. Shoddy, which is reclaimed or remanufactured wool, is made from waste pieces of wool from dressmakers' and tailors' shops and from old woolen scraps and garments that have been sold as rags. These are treated chemically to remove all the cotton, and then are torn apart so as to separate the fibers, which are spun with new yarn. The amount of wear to which the pieces were subjected will of course affect the quality of the material in which the shoddy fiber is used.

Pure silk commands so high a price that many less expensive substitutes and adulterations have been developed. *Silk is in many cases weighted with salts of tin, iron, or lead, and is sometimes adulterated by the use of cotton.* Artificial silk, a vegetable product with high luster, is now manufactured as a substitute for real silk, and is either woven with cotton or used alone. Its introduction has made the use of artificial silk stockings possible in many cases where the price of real silk hosiery was prohibitive. Good grades of artificial silk are more durable than poor grades of real silk.

Experience will teach the good buyer to judge materials both by look and by feel; one should be able to recognize the common fibers and to discover possible mixtures or substitutions. Practice with samples of various materials will help in learning to distinguish both fiber and weave.

HOW TO TEST TEXTILE GOODS.

Simple tests that may be used in the home are given as a help to those who lack experience.

Testing with the eye and the fingers.—In the first place, both warp and filling threads should be raveled in order to examine each carefully. Cotton fibers appear short, dull, and fuzzy; linen are long, fine, stiff, and lustrous; wool are short, curly or kinky, and bright; silk are very long, fine, smooth, and straight. If cotton cloth is torn, the ends of the threads appear fuzzy, while those of linen are straight and smooth. Cotton feels soft and somewhat warm; linen feels wiry and cool.

Rubbing the surface of cotton or linen briskly will remove sizing and show whether the material is closely woven; also holding a piece of material to the light will show the extent to which sizing has been used. Boiling, which is a longer process, will also remove the dressing. A drop of glycerin on linen will show a transparent spot, but cotton is not so affected.

Burning the threads.—The presence of substitute fibers in cloth may be determined by raveling separate groups of lengthwise and crosswise threads, holding them in the fingers or by tongs, lighting the ends of the threads, and noticing how they burn.

Cotton burns quickly and steadily with a yellow flame; the odor is like that of burnt paper or wood; the flame does not go out easily; a gray ash is left.

Linen burns much like cotton, and leaves an ash.

Wool burns slowly with an unsteady blue flame that goes out easily; it gives off an odor like burning hair or feathers; a ball of ash is left on the end of the fiber.

Silk burns more readily than wool and gives off a similar odor; a ball of ash is left on the end of the thread. If silk is weighted, only the silk itself burns and the mineral salts are left, making more ash than from pure silk. If the silk is heavily weighted, the ash may even retain the shape of the sample. Artificial silk burns like cotton and is very inflammable.

Chemical tests.—The following simple chemical tests may be used in the home to determine whether silk or wool materials have cotton mixed with them, and also to determine mixtures of silk and wool, silk and cotton, or artificial silk and cotton or wool. Some of the substances called for are very powerful or even poisonous, and must be handled and stored with great caution.

(1) Combination of silk and cotton or wool and cotton. Add 1 tablespoon of caustic potash or lye to 1 pint of cold water, and heat the sample of material in this solution for 15 minutes. The lye destroys the animal fiber, leaving the cotton intact.

(2) Combination of silk and cotton, or silk and wool, or artificial silk with cotton or wool. Put a sample of the material in cold

hydrochloric acid as strong as can be bought at the drug store. The solution will destroy ordinary silk in 2 minutes, and the so-called wild silk found especially in low-grade silks in a half hour or longer. Artificial silk becomes gelatinous and so tender that it washes away. The cotton or wool fibers are left.

(3) To test underwear or white material from which a sample can not be cut, for a mixture of silk and cotton or of wool and cotton, place a drop of 5 per cent solution of picric acid on an inconspicuous part of the material or the garment. As color shows on the surface, wash the spot with water. The color will disappear from the cotton, but the silk or the wool will be yellow. This stain may be removed by using ammonia, which should be promptly rinsed out with water.

Strength test.—To test the strength of a piece of material place the ends of the thumbs together, holding the material between them and the first fingers; then pull first on the warp, or lengthwise, threads and then on the woof, or crosswise, threads to see how much strain they will stand. In examining the raveled threads of a piece of cloth, notice how the warp threads compare in strength with the woof, or filling, threads. A fine warp will not stand the strain from a heavy filling thread; therefore materials so woven are not strong, neither are those which have a heavy cord woven in beside a very fine thread, as in the striped dimities and muslins.

Experience gained through testing materials that have been bought and made up, watching the length of service, and seeing the effect of weaves and surface finishes, will aid greatly when buying materials or ready-made garments.

SUITABILITY OF MATERIAL, DESIGN, AND COLOR.

CHOOSE SIMPLE DESIGNS AND GOOD MATERIALS.

Simplicity is one word that should be borne constantly in mind when choosing articles of clothing or designs from which to make them. This applies to clothing for men, women, and children alike.

Simple designs often suggest expensive materials to carry them out, but for such designs only a minimum of material is needed. Moreover, good materials are best and most economical for long, hard service, because garments made from them retain their shape, require less frequent pressing, and do not wear shabby so quickly. Standard materials and conservative designs should be chosen in preference to novelties and extremes, which serve to date a garment, make the wearer conspicuous, and are always more expensive because the manufacturer must set a price that will cover any loss he may sustain through failure to sell all his stock during the season in which it is in vogue. Bargain sales are often pitfalls for the unwary; the inexperienced shopper is tempted to buy articles that she can never use, or that do not harmonize with the rest of her wardrobe. Nevertheless in many cases extraordinarily good values may be found at

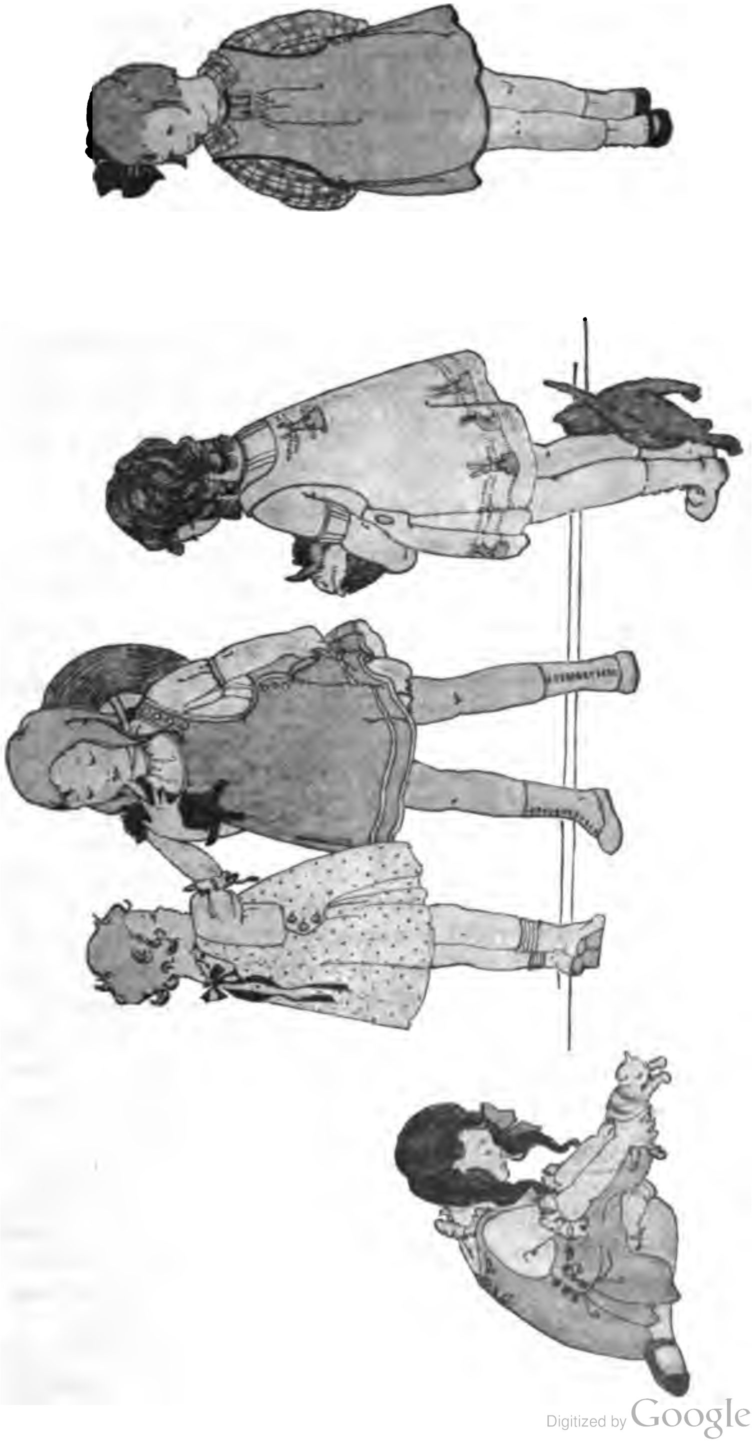

Fig. 3.—Five dresses made from one simple pattern. Variety obtained by the use of different materials and simple decorations.

pre-inventory or end-of-season sales, because the shopkeeper does not wish to carry over the stock. With the clothing plan definitely worked out in advance, great savings can often be effected in this way.

Since the fashion of men's and boys' clothing is more nearly standardized according to the purpose for which it is worn, there is comparatively little danger of making mistakes unless perhaps in the choice of the materials themselves. The adjustment of the lines of the clothing to a man's figure is cared for by the manufacturer or the custom tailor.

Clothing for children should be of the simplest kind, and such as will permit absolute freedom of movement. Children should not be conscious of their clothing either from a sense of discomfort or from pride. In clothing for small children it is often well to use one design and vary it by means of decoration, the use of two materials, and in other simple ways (fig. 3). Washable materials are preferable for children's clothing.

SUIT THE DESIGN AND MATERIAL TO THE FIGURE.

Women's clothing requires more careful thought than that for men and children. The intermediate type of figure is not difficult to clothe attractively, but the more extreme types, the slender and the stout, need careful attention. There are plain, standard designs which, with slight alterations in line and trimming, can be adapted to different types of figures and changes of style (fig. 4).

For very tall, slight people, designs should be chosen that suggest roundness and normal height (fig. 5). Soft, full blouses, full skirts, and draped effects are good; if the height seems too great, horizontal lines brought into the costume by means of flounces, bands, and tucks, will tend to reduce it. Plaids and figured materials with large areas of design are admissible on a slight, tall figure; also soft, deep-pile stuffs for coats, and bright, shimmery, lustrous materials are good.

For the stout figure, designs should be chosen that suggest height and slenderness. Loose, easy-fitting garments with straight, unbroken lines suggest height. Lines that carry the eye to the center of the figure will diminish its breadth. No lines should carry directly across the figure, for they seem to lessen the height and increase the breadth of the figure. Separate waists and skirts, unless the waist is of the same color as the skirt or is so adjusted as to fall over the skirt, will tend to broaden the figure and diminish the height. A surplice line for the opening of the waist is good; narrow girdles draped loosely about the figure, crossed in the back, and brought to the front again with one end looped over the other, suggest height. The design shown in figure 6 brings out some of these points.

The stout woman should choose soft, nonlustrous materials, such as crêpe de chine, crêpe Georgette, serge, gabardine, voile, and batiste. Plaids and large-figured materials are out of the question, and stripes should be cautiously chosen. Colors should be avoided that make the lines of the figure stand out prominently. Taupe, gray, and dark blue are usually best in this respect, but all dull, dark colors are safer than light or bright ones.

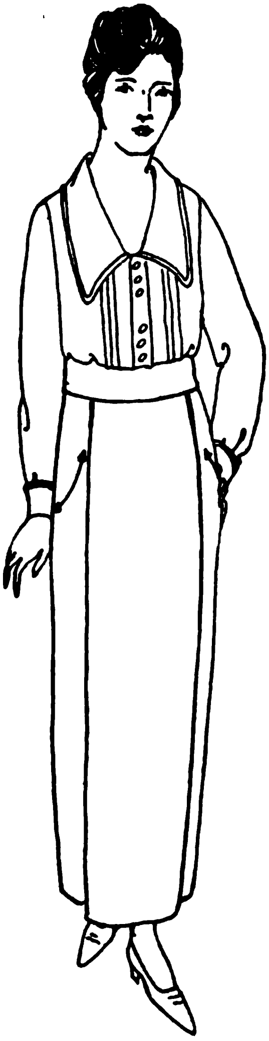

FIG. 4.—Simple blouse and skirt. These may be adapted to any figure, and with slight changes, such as in the shape of the sleeves and collar or in the amount of fullness in the skirt, are always in good style.

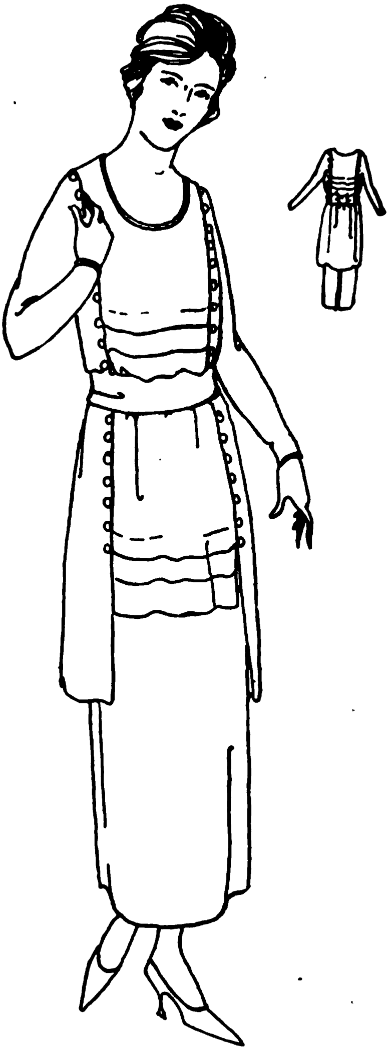

FIG. 5.—Design for tall, slender woman. The costume is divided into three distinct parts to lessen the apparent height, and horizontal tucks are used to suggest width.

SUIT THE COLORS TO THE WEARER.

Colors should be carefully chosen in reference not only to the complexion, color of the hair and eyes of the wearer, but also in relation to her figure. There is no general rule by which one can choose becoming colors. Therefore. one must rely on one's own taste, judgment, and experience. In general, women with fresh, clear complexions find a greater range of becoming colors than others who have little color, but patient experimentations will discover those which are becoming to either type. It is safe to choose such colors as are in harmony with the color of the eyes, hair, and complexion.

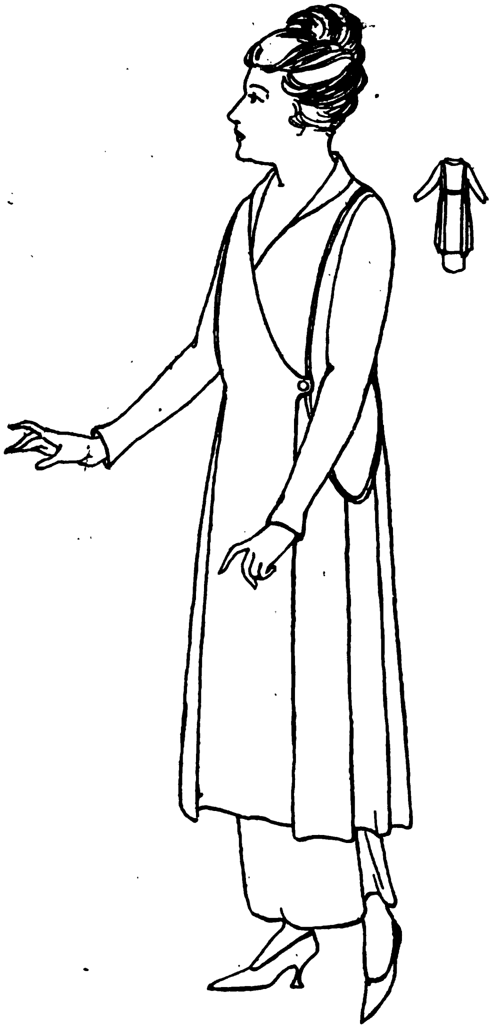

Fig. 6.—Design for stout woman. The long, straight lines suggest height; the surplice front and the curve of the side panel seem to decrease the breadth of the figure.

Dark blue is a universally becoming color. Taupe, dark blue, black, and gray in which violet predominates are good colors to be used by the woman who is stout. Bright aggressive colors make the stout figure seem larger.

Bright, gay colors may be chosen for the young, slight girlish figure, but always with a thought to the general coloring.

Having found a range of colors that are harmonious, it is well to adhere generally to these, introducing variations that may be pleasing. This permits the use of one hat, fewer gloves, ribbons, and accessories, and is therefore economical.

DESIGN AND MATERIAL SHOULD HARMONIZE.

Whether it is better to choose the designs for clothing first and then buy the material, or vice versa, must be considered from two standpoints. A design may first be selected and difficulty then experienced in finding material suitable both for the one who is to wear it, and to carry out the design; on the other hand, some especially good material may be found suitable to the wearer and to the occasions upon which it is to be worn, and yet difficulty be found in selecting a design that will work up to advantage. Another difficulty sometimes experienced by those who have not made a study of such problems is that although both design and material have been carefully chosen they are not adapted to each other. For instance, first a commercial pattern of good design may have been bought then later a plaid material pleasing in color and arrangement of lines, but the dress when made has not proved successful because this particular design brought the lines of the plaid together in an inharmonious fashion. A dress of this sort is an economic waste. If a pattern especially adapted to plaid material (fig. 7) had been chosen, this could not have happened. Experience will teach the buyer to think in triple terms of wearer, design, and materials.

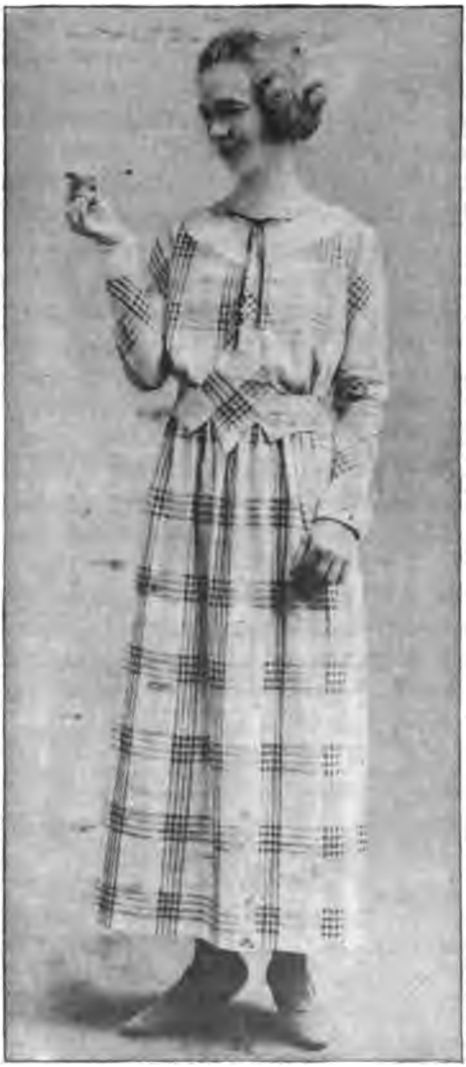

FIG. 7.—Design showing satisfactory use of plaid material. The straight waist and skirt give becoming lines, while the bias vest and sleeves furnish interesting contrast.

GOOD FITTING IS ESSENTIAL.

The fitting of any garment has much to do with its appearance and comfort. It is worth while for anyone who makes many skirts, shirt waists, and dresses at home to have a well-fitted basic pattern for each member of the family. Such patterns may be drafted at home according to standard directions or made to measure at small cost by commercial companies. The main lines of these patterns must be accurately followed, but slight changes will adapt them to various simple designs. An old garment that fits satisfactorily may be ripped and used as a pattern.

FINISH AND TRIMMINGS ARE IMPORTANT.

Materials for the decoration of clothing should be selected with regard to their fitness for the garment and the material on which they are to be used. Cotton dresses of the tailored type, such as are worn in the house, on the street, or for business, need little decoration other than machine stitching, buttons, and separate collars and cuffs of the same material or of organdie, piqué, or light-colored materials. The dresses of sheer materials for afternoon wear, graduation ceremonies, and such occasions may be very simply finished with cordings, tiny frills of lace, ribbon girdles, and fine net collars; a bit of color may be introduced sometimes merely in a string of inexpensive beads. Wool dresses may be trimmed with buttons, braid, or wool embroidery. With these also may be worn separate collars and cuffs of crêpe Georgette, satin, organdie, net, piqué, or linen. Silk dresses for afternoon wear should be kept as simple in type as others; pipings, cordings, silk or wool embroidery, and net, organdie, or crêpe Georgette collars and cuffs are suitable for decoration and finish.

UNDERWEAR.

Women's and girls' undergarments should be of durable material and simple design. Dainty, well-made lace or embroidery edgings should be chosen. Elaborate trimming is in bad taste and moreover does not wear well. For everyday use there are a number of attractive self-trimmings (for example, tucks, shaped hems, and facings) and ornamental stitches (feather stitchings, Bermuda fagoting) that are easily made and launder well. The tendency to overdecorate undergarments is to be deplored.

Knitted underwear, socks, and stockings should be well shaped to provide for both comfort and service. Socks and stockings may be of cotton, wool, or silk, and should be long enough not to cramp the toes.

OUTER GARMENTS.

All outer clothing, men's and boys' suits and overcoats, women's and girls' suits and topcoats, should be selected from the standpoint of good materials and workmanship, their suitability to the wearer's needs, and becomingness of line and color. Careful attention should be given not only to the quality of material but to the general workmanship, cut, fit, manner of finish of seams, pockets, belts, and buttonholes—all of which count for service.

Simple one-piece dresses of wool for cold weather and of silk for summer are suitable for business women. The advantage of silk in summer is the saving in laundry bills, as an occasional cleaning at a professional establishment during the season will keep the dress in order and the wearer may further preserve its fresh appearance throughout the summer by frequent changes of collars and cuffs.

The same type of dress is appropriate also for the afternoon wear of the woman who is at home. For hard work she will probably prefer an inexpensive one that can be washed easily and frequently.

For use with the one-piece dress, a topcoat is necessary. The latter may often need to serve the purpose of business and dress wear, in which case it would be wiser to buy a raincoat for use in bad weather, to save wear and tear on the other coat. If one can not afford both a heavy and a light-weight topcoat, it may be better to buy one of medium weight and depend upon an underjacket or a piece of fur for extra warmth. For general wear some women prefer a topcoat and one-piece dress to a suit; suits, however, have a legitimate place in the woman's wardrobe, especially when combined with a waist of the same color. A good plan is to alternate the buying of the more expensive garments; for instance, not to buy a topcoat and a suit during the same season. This same plan may be carried out in the purchase of all expensive garments, whether for men, women, or children.

Blouses and separate waists for women are best made of washable materials, such as voile, batiste, handkerchief linen, crêpe de chine, crêpe Georgette, and washable silks, or madras and gingham for hard wear. The cotton materials require more frequent laundering than crêpe de chine and crêpe Georgette. Voile can be worn much longer without pressing than can any of the other cottons. Handkerchief linen is not very satisfactory because it crushes easily. For general wear tailored waists made of batiste, crêpe de chine, wash silk, or silk broadcloth, are especially suitable; simple blouses of sheer materials are also suitable when careful attention is given to detachable linings or to undergarments.

HATS.

Hats that are good in line and well made do not necessarily represent a large outlay of money. Of course, the woman who is skilled enough to make and trim her hats attractively has a great advantage over the one who must buy hers. The latter, however, if she is a good shopper, will learn to buy in good shops, and may perhaps choose a late season's model which, being well made and of good shape, will be serviceable through the beginning of the following season.

A hat is a frame for the face; therefore its lines should conform to the shape of the face and the head and to the fashion of dressing the hair. In color the hat should harmonize with the costume and the coloring of the wearer. A hat should be so worn as to carry out the idea of a suitable setting for the face, not perched conspicuously on the top of the head nor tipped back too far. The head size of a hat should be such that it will rest on the head easily and comfortably. Many of the small hats of to-day are so well shaped and fitted that they can be worn without hatpins.

There are four general types of women's hats that are always in vogue (fig. 8). Of these, the toque or the turban will serve the most purposes. Tall, slender women have more latitude in the choice of hats, especially of brims, than have short, stout women. Broad brims, particularly if they droop, appear to lessen the height of the figure, while brims that roll up on one side seem to increase the height. Height may be suggested for a short, stout figure by a hat with a crown higher on one side than on the other, or by trimming placed toward the back of the hat on one side. In order to get the effect of hats, it is well to try them before a full-length mirror and if possible with the costume with which they will be most worn.

SHOES.

Shoes should be chosen chiefly for comfort and durability. The heel should be of the height that makes the foot most comfortable. If possible, it is well to find one make of shoes well suited to the foot, and then adopt it for both walking and dress shoes. Unless one can afford several pairs of shoes to match different costumes, it is better to buy black, for they are always acceptable for either street or dress wear.

GLOVES.

Gloves should be chosen for comfort, durability, and shapeliness. Gloves bought at bargain sales do not always come up to expectations. End-of-season lots or "seconds" at the best stores will often give good satisfaction. A well-shaped glove will outwear a cheap, poorly-made one and add to the wearer's good appearance. White gloves require frequent cleansing, but colored gloves can not be guaranteed to hold the color in washing; therefore in many cases white gloves are more satisfactory. Cotton fabric gloves may often be used in place of kid to save expense, while silk gloves are so attractively made that they can take the place of kid throughout the warmer weather. White washable kid gloves are also serviceable. Woolen gloves and mittens afford warmth in winter and give long service.

CARE OF CLOTHING.

Garments even of the best quality, design, and workmanship will soon become shabby through lack of care; while those that may perhaps have cost only half as much may be kept fresh looking for a considerable length of time by the painstaking care of the wearer.

One of the greatest helps in keeping clothing in good condition is to give immediate attention to the repairs, such as mending rips and torn places, sewing on loosened buttons, fasteners, and trimmings, and reworking worn buttonholes. Also "preventive" darning may lengthen the period of service of many a garment. This is done by reenforcing a worn place with rows of fine stitches or by laying a

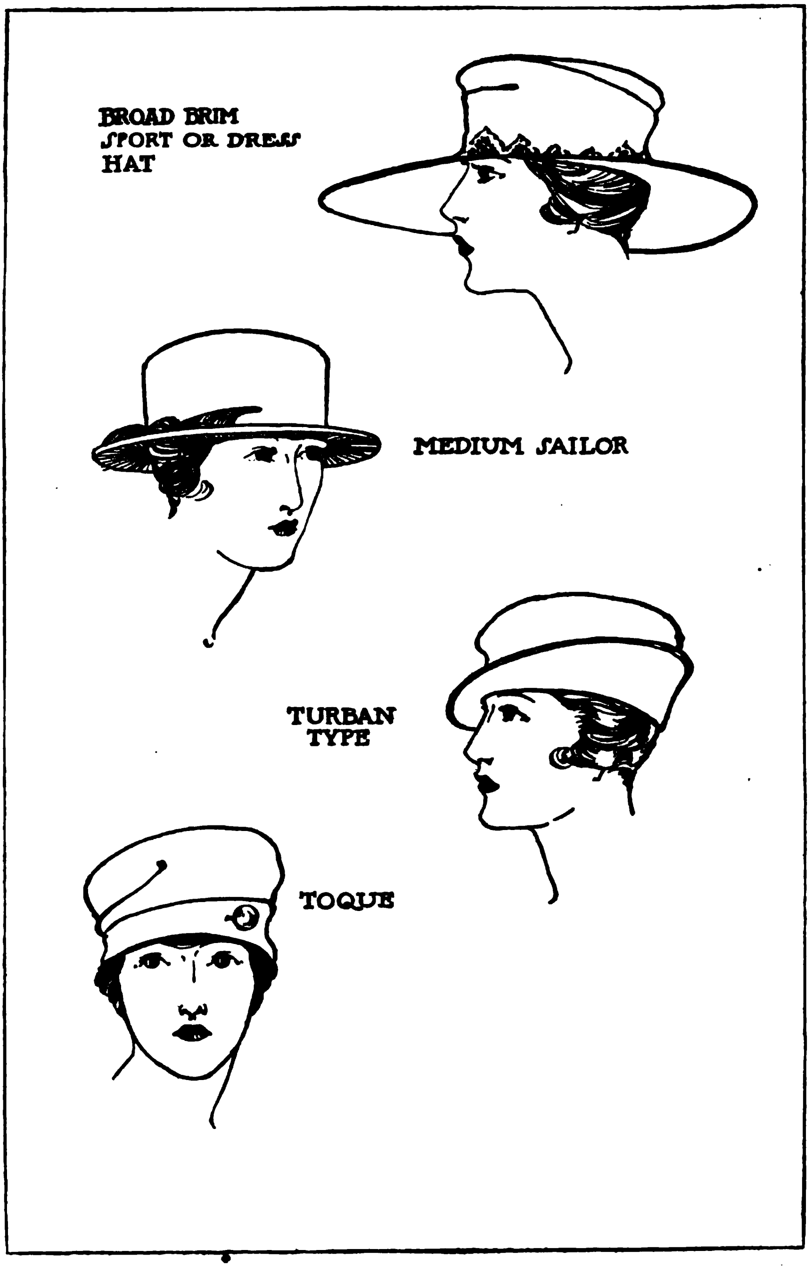

FIG. 8.—Four general types of hats. With slight variations in the size of the crown, the width of the brim, and the use of trimmings, such hats are always in vogue.

piece of cloth (like the garment if possible) under it and darning it down with ravelings of the material.

Cleanliness demands that all outer clothing should be rid of the accumulation of dust and dirt immediately after wearing. Silk and woolen garments and hats should be brushed. If one can afford them, it is well to have a collection of brushes suited to various materials, for example, one with rather short stiff bristles for heavy woolen outer clothing, a whiskbroom for general brushing, a softer bristle brush for velvet or silk, and a specially shaped soft brush for hats. A piece of velvet is also good to use for brushing dust from silk or satin. Underclothing and all other washable garments should be washed before they become so soiled that hard rubbing is necessary. Cleanliness increases the length of service from a garment and hence is real economy. This is particularly true of stockings. Frequent washing prolongs their life for two reasons; it removes perspiration and grit, which damage the fibers, and it changes the place where the strain of wear comes. The sense of comfort and self-respect that clean clothing gives will repay all the effort that it costs.

All clothing, including shoes, should be aired after wearing. Perspiration will cause wrinkles and disagreeable odors and tend to rot fabrics, unless the garments are placed in a good circulation of air before they are put in closets and boxes. Brushing and airing clothes often, and when possible out-of-doors, will do much toward keeping them fresh and clean and should supplement the nightly airing needed by garments in constant use.

The immediate removal of spots, especially from woolen garments, is desirable because dust settles in them and makes later cleansing more difficult. Methods of removing spots and stains may be found in other publications of this department.[1]

The care of clothing is less expensive if one can press the garments at home. To do this easily requires special equipment, but good results may be obtained with the ordinary household equipment, with the addition of a heavy cotton cloth to use in pressing woolens. An ideal equipment, which might be acquired by making occasional additions to the appliances already in the house, consists of an ironing board of the type used for skirts, a sleeve board, a seam board, a tailor's press board, a tailor's cushion, irons, wax, cloth for rubbing off the iron after waxing, a press cloth, cheesecloth or old thin muslin, and an old bath towel.

The seam board is a triangular board, about 18 inches long, and has the upper edge slightly rounded; it is slipped into sleeves when seams are to be pressed open. The tailor's press board is supported by two upright pieces set on a heavy base. It may be used on any table and is excellent for pressing shaped and tailored garments, such as coats. The tailor's cushion, sometimes called a ham, is oval in shape and narrower at one end than at the other; it is made of heavy cotton duck, stuffed very tight with wet woolen rags, then dried in the hot sun or in a cool oven to prevent mildew. It is used in pressing parts of garments that are curved, such as the bust of a coat. Smaller cushions made in the same way are used for the tops of sleeves. (Fig. 9.)

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[1] U. S. Dept. Agr., Farmers' Bul. No. 861. U. S. Thrift Leaflet No. 6.

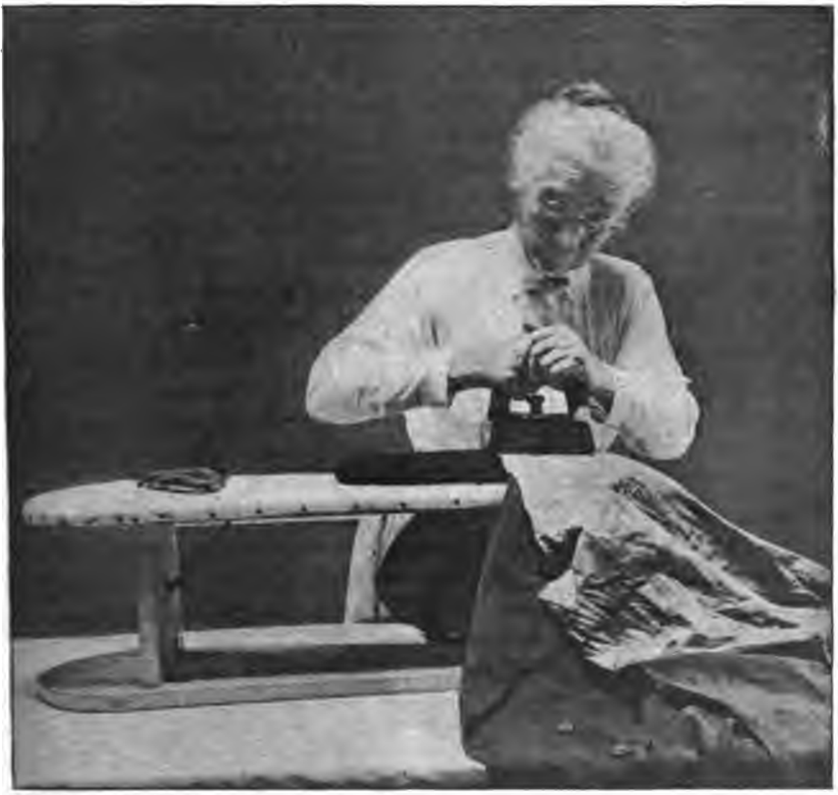

FIG. 9.—Using a pressing cushion.

A strip made of heavy cotton duck 1¼ yards in length makes a satisfactory press cloth, because when thoroughly wet it does not dry out quickly under the heat of the iron. An old bath towel provides a soft surface for pressing embroidered garments; it may also be used to wrap up silk waists immediately after rinsing and thus to absorb some of the water before they are ironed.

CARE OF WOOLEN COATS, SUITS, AND DRESSES.

Woolen garments should be thoroughly brushed, care being taken to brush with the nap if the cloth has such a surface, and then well shaken to remove lint and bits of dirt. The edges of tucks should be turned back so as to remove the dust and lint that accumulates underneath. Pockets should be turned wrong side out, and stitching and the under side of seams should also be carefully brushed.

When woolen fibers are dampened and then dried, they keep the shape they had when damp. In airing woolen outer garments it is therefore necessary either to protect them against dampness or to hang them so that wrinkles will not dry in them. Slight wrinkles may often be removed by hanging the garment over a bathtub filled with water hot enough to steam, and then drying it thoroughly before wearing it or hanging it in the closet.

All spots should be removed after the garments are brushed. Sometimes a little clear water will remove a spot made by a drop of sirup, but for a spot made by grease a special cleaning agent may be necessary. Collars and lower edges of sleeves on all suits and coats need frequent cleaning. Directions for removing spots and stains, as well as for the use of various chemicals and for cleaning and washing garments, are found in other publications of this department,[1] and much minor cleaning may be done at home in a very satisfactory way if the suggestions there given are accurately followed. The cleaning of fabrics of delicate color and texture, of elaborate garments, and the removal of obstinate stains should in many cases be left to the professional establishment, as such work requires special skill and equipment.

Tears in woolens may be darned with ravelings of the material, sewing silk, or strands of hair, sometimes so skillfully that they can not be detected; a tear in a garment not given hard usage may perhaps be repaired invisibly by the use of mending tissue. This way of mending is not so durable as darning, and is not recommended for a tear that does not show or that can be satisfactorily darned.

When the edges of coat sleeves become worn, the hems may be ripped, the worn places carefully darned, and slightly deeper hems turned so as to conceal the darning. A worn lower edge of men's trousers may also be repaired by ripping the hem, darning the worn places, and facing the edge with a narrow strip of firm woolen cloth, such as light-weight broadcloth. A thin place in the seat of trousers or in the knees of boy's trousers may be reenforced by a piece of firm cotton cloth of suitable color, darned down with fine stitches to the inside of the trousers. An inner lining of thin cotton goods at the knees of men's trousers adds much to the comfort of the wearer if knee-length underwear is used.

Careful pressing will do much to keep woolen clothing in shape, and thereby to prolong its period of wear. The garment should be laid on the board and covered with the press cloth, which has been thoroughly soaked in water and well wrung out. An iron not too hot should be moved back and forth over the press cloth until it is nearly dry. If it becomes absolutely dry, shine is likely to appear on the garment. The garment should then be hung where there is a good circulation of air and allowed to dry thoroughly before it is put away.

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[1] U. S. Dept. Agr., Farmers' Bul. No. 861, and U. S. Thrift Leaflets Nos. 5, 6, 7, and 8.

Parts that have worn shiny should be sponged with ammonia water (1 tablespoon of ammonia to 1 quart of water), covered with a wet press cloth, and pressed with a medium-hot iron until the press cloth is almost dry. The cloth should then be removed, the garment brushed with a stiff brush to raise the nap, and the cloth pressed again, care being taken not to let it become dry.

Bagginess at the knees of trousers or at the elbows of coats may in many cases be shrunk out by spreading the garment flat on the board, placing a well-dampened press cloth over the baggy portion, and pressing until the press cloth is not quite dry.

CARE OF SILK CLOTHING.

Silk garments should be brushed carefully with a piece of velvet or a very soft brush. Silk may be cut or marred by too vigorous brushing. Spots may be removed in much the same way as from woolen garments (p. 24). Silk garments may be dry-cleaned at home if one is very careful to use gasoline or other inflammable fluids out-of-doors where there can be no risk of explosions; or it may be advisable to send them to the professional cleaner, since he has special appliances. A suds made of neutral white soap or soap chips and cold or lukewarm water should be used for washable silk garments. If white silk shirts and waists are washed in such suds, rinsed in water of the same temperature, wrapped in a bath towel to absorb the extra moisture, and then pressed with a warm iron they will not turn yellow for a long time. Silk must be pressed carefully; in fact irons should be used on it as little as possible, during either making or wear. The dressing in new silk socks and stockings tends to make the threads break and should be washed out before they are worn. Further directions for cleaning silks are contained in other publications of this department.[1]

Wrinkles may sometimes be removed from a silk dress by hanging it over a bathtub filled with water hot enough to steam and then drying it where nothing will touch it.

CARE OF COTTON AND LINEN CLOTHING.

Cotton and linen clothes do not hold dust in the same way that wool and silk do; therefore, it is sufficient to shake them to remove the dust. Brushing tends to rub the dirt into the fiber.

Cotton and linen garments, especially those that touch the skin or are worn in hot weather, should be carefully aired and frequently washed, because they absorb oil and perspiration from the body.

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[1] Farmers' Bul. No. 861, and U. S. Thrift Leaflets Nos. 5, 6, 7, and 8.

Too frequent pressing of partly soiled white washable garments will tend to yellow them, and colored ones may be permanently discolored in this way. In pressing cotton or linen material it must be evenly dampened, and the iron must be perfectly clean and free from rust; otherwise the material is likely to be stained with rust.

Small holes may often be invisibly darned with very fine thread, and tears or larger holes may be patched with a hemmed patch where strength is needed, or with an overhanded patch, which is less visible and not quite so strong. In some cases the torn part of the garment may be replaced with new material, which may have to be shrunk or faded to match the old. All torn places in laces or embroideries should be mended as soon as they are noticed. Embroidery or lace may be darned, the threads rewoven, or new pieces set in. If buttons or fastenings have pulled off, tearing the cloth, a strip of narrow linen or cotton tape may be hemmed to each side of the garment and the fastenings sewed to this.

CARE OF HATS.

Hats should be cared for properly not only because it is an economy but also because the condition of the hat and the way in which it is worn may make or mar a person's appearance.

A hat should be carefully brushed with a soft brush to remove all dust not only from the hat itself but from the folds of the trimming. A piece of velvet should be used to wipe the dust from silk or satin hats. Straw hats may be wiped with a cloth dipped in alcohol to remove dust.

For a hat with a brim that is easily marred, a hatstand either of the commercial type or made at home out of a strip of stiff heavy paper about 9 or 10 inches wide and rolled so as to be narrower at the top than at the base, is good because it keeps the brim of the hat from rubbing against the shelf or the bottom of the box. Tissue paper laid over the top of the hat will protect it from dust. A hat not in constant use should be stored in a box as dust proof as possible and as a further precaution the top of the box may be covered with tissue paper.

Trimmings that become loosened by wind or wear should be tacked into place in the following way: Thread a long needle (preferably a milliner's needle) with coarse thread or silk of a color that will not be conspicuous. Draw the needle from the wrong side through the hat beside the loosened trimming, leaving 2 or 3 inches of thread on the wrong side; pass the needle up and down around the trimming and back to the wrong side of the hat; pull the thread through; tie the two ends securely and cut them a quarter of an inch beyond the knot.

A velvet or silk hat wet by a shower should be hung over a stove or a radiator, care being taken to keep the hat in shape and prevent its being marred by touching anything. This treatment may save the price of freshening or even of a new hat.

Hats that have been badly wet and then dried are often improved by careful steaming. This may be done by holding the outside of the hat over the spout of a boiling teakettle or over a wet cloth placed on a hot inverted iron. Wire stands made for the purpose of holding the iron in this position can be purchased.

CARE OF GLOVES.

Kid gloves should be carefully drawn from the hands, not pulled off by the finger tips. When the glove has been drawn off, the fingers may be inflated by blowing into the glove, then the fingers should be pulled gently before putting the gloves away. Silk gloves may be turned wrong side out in drawing them off the hands. Cotton gloves will stand hard usage, but some care should be exercised to prevent the stitching from loosening at the finger tips.

Gloves should always be put away in pairs and the thumbs should be folded over on the gloves. Long narrow boxes or baskets are good containers for gloves. Kid gloves are an expensive luxury if sent continually to the commercial cleanser, but they may be cleaned at home if one has the time. One method that has seemed practical is to rub the soiled parts of the gloves with cornmeal, moistened with enough gasoline to keep the meal from scratching the gloves, then to dry them thoroughly in the air. Another method is to shake them up and down in a fruit jar partly filled with gasoline, changing the gasoline until it remains clear. Gasoline must always be used in the open air, because it is very inflammable and explosive. White kid gloves clean more satisfactorily than the colored.

Washable kid gloves may be cleaned by putting them on the hands and washing them in lukewarm suds made with neutral white soap, rinsing them thoroughly, and drying them slowly. A little talcum powder rubbed in after the gloves are dry restores the soft finish to many kinds.

Silk gloves are best washed in cold or lukewarm suds made with good white soap or white soap chips; they should be well rinsed. It is better to wash white silk gloves at night, to prevent their turning yellow from the combined effect of light and moisture.

Cotton fabric gloves may be washed in lukewarm suds, rinsed, and hung in the air to dry.

Gloves often repay the labor of repairs, especially if put in order when the hole or the rip first appears. For mending kid, a short needle should be used and cotton thread rather than silk because the latter tends to tear the kid. Small rips should be sewn to match the original stitching as nearly as possible. For a large hole or in case the kid is weak, the edges may be buttonholed and then the two opposite rows of buttonholing overhanded together; this makes a strong seam. Sometimes torn places may be patched with a bit of kid from an old glove of similar color. Fabric gloves may be darned with fine soft thread. Many glove dealers will mend torn places for a small sum and should do it without charge on defective gloves of good quality from their own shop. If a snapper pulls out, the dealer from whom the gloves were purchased will probably replace it, or an ordinary snap fastener, such as is used on dresses, may be substituted.

CARE OF SHOES.

Careful poise of the body in walking prolongs the life of shoes. A careless, slipshod gait wears shoes unevenly, while an erect carriage tends to keep the soles and heels level.

Shoes, even more than most other articles of clothing, need to be aired after wearing in order to prevent the perspiration from rotting the lining. It is a good plan to keep them on shoe-trees or stuffed with tissue paper, because in this way the wrinkles are forced out and the original shape is preserved. Wetting tends to spoil the appearance of shoes and to shorten their period of service; therefore overshoes should be worn in bad weather to protect the shoes. If shoes do get wet, they should be very slowly and carefully dried, for heat tends to crack the leather. It is especially important to restore the shape of wet shoes by shoe-trees or paper stuffing. Even with the most careful drying, moisture tends to rot the threads with which a shoe is sewn, and "an ounce of prevention is worth a pound of cure."

For walking in snow or deep mud, arctics with rubber soles and waterproof cloth tops afford excellent protection, as do also rubber boots. When only a little protection is needed, the slip-on, or sandal, is comfortable and economical, for it covers the sole of the shoe but leaves the heel free. All types of rubber overshoes are now so expensive that they should be treated as carefully as the shoes they protect. They should be kept away from great heat, and set "right side up with care" to prevent their losing shape. They should also be washed, or brushed so that the grit on them may not wear down the surface.

It is economy to keep two pairs of shoes in use and wear them on alternate days; the thorough airing on shoe-trees or stuffed with paper keeps them fresher and more shapely so that each pair gives longer service. All shoes should be kept clean and well brushed. Leather shoes may be rubbed with vaseline to keep them soft, and also to keep moisture from passing so quickly through the leather. Only good polishes should be used. In using paste polishes, a brush is preferable to a cloth, as it will force the paste into all crevices. The shoes should stand a few minutes after the paste is applied; then they should be brushed with a flat stiff brush and polished with a cloth or a buffer, a brush made of layers of cloth having a napped surface. A glove made of sheepskin with the wool on, such as is used for rubbing furniture, is also very good for polishing shoes.

White canvas shoes are usually cleaned with one of the commercial preparations for this purpose. If water is used, no more than necessary should be applied on the shoes and they must be cleaned on shoe-trees or stuffed with paper to prevent the canvas from shrinking. If they are badly soiled, they may be washed with a soap that contains whiting, dried, and if necessary treated with a commercial cleaner. All traces of the cleaner should be carefully wiped from the edges of a colored sole; otherwise the shoe will have a slovenly appearance. White suede and buckskin shoes are cleaned in much the same general way, but with special cleaners made for the purpose.

Where conservation of space is not necessary, a small chest for holding shoes may be added to the furnishings of the bedroom; or shoe bags hung on the inside of the closet door are good. Pairs of bags in different colors are very useful for packing shoes when traveling; they keep the shoes from being scratched, prevent them from soiling other articles, and make it possible to sort out a particular pair quickly.

Shoe repairing has become such an art that shoes must be of very poor leather indeed if they will not stand repairs. Run-down heels spoil the shape of shoes and should be leveled at once. If the shoes are of good leather, well shaped, and well made, it is worth while to have full soles hand sewed on them and new heels put on when the first set wears through. Shoes thus mended will outwear those repaired with ordinary half soles, and also have a much better appearance. Brass rather than iron nails in the heels make less noise in walking. Rubber heels prevent jarring in walking and for this reason are very comfortable; for some persons they seem to wear longer than leather heels.

STORING CLOTHING.

Storage facilities whether for clothing in daily use or for that put away for the season should provide for an orderly arrangement in chests, closets, or drawers. If the closet is fitted with a rod to hold hangers, the space can be used to better advantage. Closets and cupboards filled with clothing should be frequently aired. A good plan is to leave the door of the clothes closet in the bedroom open every night.

Special covers are useful to protect garments left hanging for some time. Dainty covers for delicate dresses may be made of dimity or lawn, and heavier ones for general use of cheap calico. A well-shaped cover of this sort is shown in figure 10. It is made of two strips of material, the longer one being buttoned up on the other to keep out dust at the bottom. It is shaped at the shoulder and has a neck piece through which the coat hanger passes. A cover of this kind may be bound on the edges or finished with plain seams and hemmed at bottom and top. Short covers for waists or for dresses with delicate yokes and fronts are also useful.

If the storage space is limited, a bed box, or long, shallow, wooden box equipped with hinged cover and castors so that it can be rolled under the bed out of sight, may prove useful; or an upholstered box couch may be used for the double purpose of couch and packing box. Portable closets, made of heavy cloth supported by an iron frame, are on the market in some places.

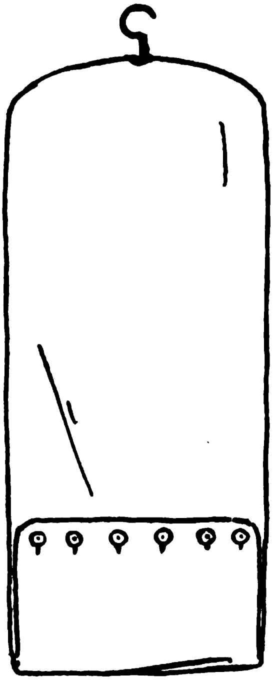

FIG. 10.—Dress cover for use with hanger.

All garments should be put away clean. The longer a fabric remains soiled, the harder it is to clean. Many stains, including those from perspiration, grow deeper in color with time until it is almost impossible to remove them. Also moths are much more likely to attack soiled garments than those that have been thoroughly cleaned.

When garments are put away for the season, they must be protected against wrinkling, stretching, rubbing, dust, change of color, and insects. Coats, suits, skirts, and dresses are often best left hanging in the closet, provided they are covered. Circular skirts, heavily trimmed garments, or those made of loose sleazy materials, however, should not be left hanging because they are likely to stretch. Dresses and waists of delicate fabrics should be carefully folded and laid in separate boxes. When outer garments are put away folded, care should be taken to have the folds correspond as nearly as possible to those into which the garments fall in use, and nothing heavy should be allowed to rest on them. Garments of delicate color should be stored in the dark to prevent their fading.

Woolen and silk garments should be thoroughly brushed inside and out in order to remove moth eggs. Moth millers and carpet beetles do not themselves harm fabrics, but they lay eggs from which develop caterpillars that feed on woolens and silks. Cedar chips, oil of cedar, moth balls, and other repellents placed in the closet, the bag, or the box in which a garment is stored may prevent millers from laying their eggs in it, but they should not be relied on to prevent eggs already there from hatching. For this reason careful cleaning and wrapping are a better protection than repellents used alone.

Heavy moth-proof paper bags may be bought for storing and silk garments. Homemade ones of newspaper or thick are equally efficient, provided there are no holes through which millers may enter and in addition some repellent is put in the b drive the millers away.

Hats when put away for the season should be thoroughly brushed; if the trimming can not be worn again as it is, it should be ripped off. If space allows, each hat should be packed in a roomy box by itself, preferably with tissue paper, to prevent it from being rubbed and marred. Felt or cloth hats, feathers, fur and woolen trimmings must be protected against moths in the same way as woolen garments.

SOME ARTICLES NEEDED FOR THE CARE OF CLOTHING.

The task of keeping garments in order will be much easier if the necessary supplies are kept together in a convenient place.

Every woman who has much mending to do should have a comfortable chair set in good light, and near it she should keep a well-stocked mending basket. In this should be a pincushion or a needle-book in which are needles threaded with silk and cotton thread of different sizes and colors, ready for emergency work. The basket should also contain whatever sewing materials experience has proved most useful for her particular needs. They should include at least the following:

Hooks and eyes.
Snap fasteners.
Buttons.
Sewing thread of different colors.
Sewing silk.
Tape of several widths.
Small pieces of cotton, linen, woolen, and silk materials for patching.
Darning cotton.
Mending tissue.
Scissors.
Thimble.
Emery.
Needles.
Pins.

Also a good plan is to have each bedroom, including the guest room, equipped with a small box or basket containing the articles most commonly used in mending. Anyone who travels frequently will find useful a compact little sewing kit that can be slipped into the traveling bag.

It is also desirable to keep some of the things most used for removing spots and stains where one can get at them quickly. In many households these are kept in the laundry, but in others it is found convenient to keep in the bathroom a nonexplosive solvent, such as carbon tetrachloride, an absorbent, such as magnesia, a little blotting paper, borax, ammonia, a small glass rod with rounded end, a small sponge, and possibly a small bowl. A person is more likely to wash out gloves, silk stockings, collars, and other small articles promptly, if the proper kind of soap and perhaps a little bluing are at hand. Experienced travelers often carry with them small amounts of such materials.

ought are necessary in order to keep the individual aring apparel above reproach in appearance and to as long as possible, but keeping supplies at hand, etails, and making repairs promptly will in the long run ous returns in time, money, and materials saved.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

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FARMERS' BULLETIN 1090
UNITED STATES DEPARTMENT OF AGRICULTURE

Rabbit Raising

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THE SAVING AND EARNING possibilities of rabbit raising are illustrated by the following concrete examples of what has actually been done:

One resident of Kansas City, Kans., has raised 300 to 400 pounds of rabbit meat a year for his own table at a cost of only 8 to 10 cents a pound. A large religious institution in Nebraska that has raised rabbits instead of poultry reports the meat more satisfactory than chicken and the experiment profitable. According to a former county commissioner of the State of Washington, rabbits were grown on the county farm to provide a substitute for chicken for the county hospitals; the initial stock, numbering 119 rabbits, increased to 1,200 in 10 months, besides those used in the hospitals. A high-school boy in Iowa, who breeds registered stock on a space 33 feet square in his back yard, raised and sold enough rabbits in 1918 to clear more than $1,200. An Ohio farmer sends 400 pounds of rabbit meat a week to city restaurants, yet is unable to meet the demand.

These are not isolated cases; they are simply examples of what has been done in rabbit raising, and are an indication of what this industry is likely to become when it is generally understood.

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief
Washington, D. C. March, 1920

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RABBIT RAISING.

Ned Dearborn, *Assistant Biologist.*[1]

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UTILITY RABBITS.

DOMESTICATED RABBITS have been bred in America and exhibited at pet stock shows as a kind of sport for many years. They are gentle and attractive. People who raise them find real pleasure in breeding them to conform to chosen standards of size, shape, and color, and there has been a keen competition among rabbit fanciers in their endeavors to produce prize winners. An essential part of their work has been an intensive study of the qualities and requirements of the animals. This has not only enabled them to raise fancy rabbits successfully, but has also disclosed the way to turn their product to practical uses. It is now well known that rabbit meat is as fine as that of poultry; and that a prolific 10-pound doe can easily raise in a year 20 young, which at 5 months will produce not less than 50 pounds of delicious meat. By means of compound hutches all this can be done on an area 4 by 6 feet. Half an hour of time a day, and some hay, roadside weeds, and refuse from orchard, garden, and kitchen, supplemented by a small quantity of grain, cover the cost of production. Raising rabbit meat for home consumption is a proposition for turning to account time, space, and materials which are ordinarily wasted. As such it appeals very strongly to prudent people. In regions where rabbit breeding is practiced extensively, rabbit meat is in common use and has a place with other kinds of meat in daily market reports.

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[1] This bulletin is based on a manuscript prepared by Prof. David E. Lantz, shortly before his death, October 7, 1918, but the accumulation of new material has made it necessary that it be completely rewritten and considerably extended.—Editor.

Rabbit raising is light work and thus is suitable for persons unable to engage in a more laborious occupation. It is especially attractive to young people, who in it may turn their energies into a profitable channel and incidentally acquire a knowledge of the principles of animal husbandry. Boys' and girls' clubs organized by the United States Department of Agriculture and by State agricultural colleges have been a most important factor in demonstrating the good points of rabbits. The large number of requests for information constantly being received by the department is a sure indication of a great popular interest in rabbit raising, and it is confidently expected that the production of rabbit meat and fur for home use will steadily increase.

Rabbits have been kept on the farms and in the towns of northern France and Belgium for home use and for market as commonly as poultry. About 100,000,000 rabbits have been marketed annually in France, and approximately 2,200,000 were raised in Belgium in 1898 for home consumption and for export. The value of rabbits annually exported from Ostend to England has exceeded $1,000,000; the value of wild rabbit meat imported into Great Britain through London from Australia and New Zealand was $4,500,000 in 1910; while England herself was producing from 30,000,000 to 40,000,000 rabbits.

In the United States wild rabbits always have been an important source of food, especially during the cold part of the year, but the value of the domesticated rabbit as a producer of food and fur had never been fully appreciated until the conditions resulting from the great war awakened many of our people to its economic importance.

The first object in rabbit raising is to supply home needs. The best indorsement an article can have is the fact that it is used freely by its producer. If one is inclined to disdain domesticated rabbits on account of experience with wild rabbits, he should know that the latter, as sold in butcher shops, are not to be compared with tender young hutch rabbits. The flesh of the tame rabbit is a highly nutritious and desirable food, resembling somewhat the white meat of chicken. Wherever it has been introduced in the markets it has become popular and the demand for it has steadily grown.

BREEDS.

The family of hares and rabbits[1] is distributed over the greater part of the world and comprises a large number of species and races. It is of considerable economic importance, as it furnishes sport and partial subsistence and clothing to the inhabitants of many countries. The skins supply warm garments for natives of northern latitudes and are used in temperate climates in the manufacture of furs. The hair, sheared from the pelts, is utilized extensively in making hats, and mixed with wool or cotton, is made into cloth.

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[1] Leporidae.

Only one species of the family of hares and rabbits has been domesticated. This is the European rabbit.[1] native, probably, of southern Europe, it has been introduced in the wild state into most of northern Europe, northern Africa, Australia, New Zealand, and other countries. In the domesticated state it has been carried to many parts of the world, until rabbit breeding has become an important industry in Europe and parts of America. Under domestication the rabbit has proved to be a plastic species in the hands of the breeder and has been modified as to size, form, color, and other superficial characters until a large number of distinct varieties, or breeds, have been produced. Out of more than 20 of these breeds now established in American rabbitries, there are 3 types which, because of their large size, are classed as utility rabbits. These are the Belgian hare, the New Zealand red rabbits, and the so-called "giants," including the several color varieties. At present the smaller breeds are kept as fancy stock, but it is quite possible that some of them may be utilized eventually in the production of fur and wool.

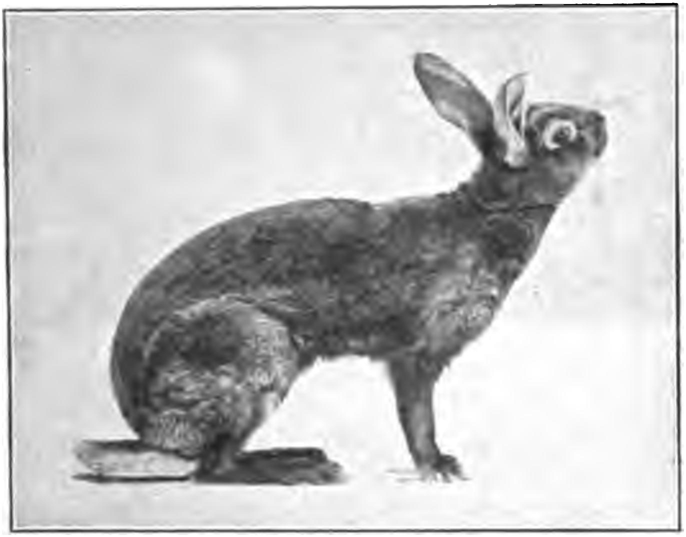
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FIG. 1.—Belgian hare.

BELGIAN HARES.

The Belgian hare has long been a favorite in America and abroad. It develops rapidly, furnishes meat that is white and tender, and, as it has small bones, makes less waste than do the larger breeds. It is a long, slender, racy-looking rabbit. The name hare is applied to it only because of its general resemblance to the European wild hare. The American standard now requires a rich, deep, dark cherry-red or light mahogany color, which should be uniform over head, ears, chest, feet, and body. The ears should be straight, about 5 inches long, and have fine black edging or lacing near the tips. The standard weight for adult does is 8 pounds; an earlier standard was 10 pounds.

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[1] *Oryctologus cuniculus.*

The "rufous red" is not a distinct breed, but is merely a Belgian hare which conforms to the present American standard in size and deep color.

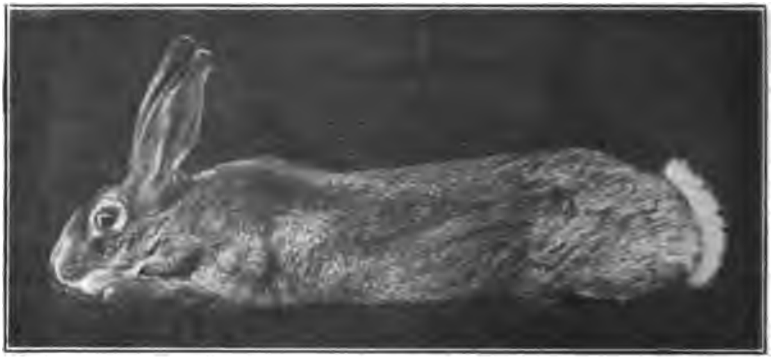

FIG. 2.—Gray giant rabbit.

The Belgian giant is a cross between the Belgian hare and the gray Flemish giant. It has a larger frame and heavier bones than the Belgian, and at 12 months the adult should weigh nearly or quite 12 pounds. It has much to commend it for utility purposes.

FLEMISH GIANTS.

Flemish giant rabbits originated in Europe and were derived from an old breed of rabbits known as the Patagonians, or Patagonian giants. They were not originally a fixed type as to color, but through careful selective breeding a number of standard varieties have been developed and fixed. These are known as steel gray, dark steel gray, gray, checkered, white, and black (the last sometimes called "Black Siberian hare," see p. 11).

The Flemish giants are excellent utility rabbits and have a high reputation as meat producers. They are adapted to either outdoor or indoor management and are now bred in all parts of the country. They grow rapidly, withstand cold well, and are highly recommended where the market demands a heavy type of rabbit.

The gray Flemish giants are the largest rabbits bred by American fanciers. They attain their full development at about 15 months, when the bucks should weigh 13 pounds or more and the does not less than 15 pounds. The adult does have the appendage known as "dew lap" well developed.

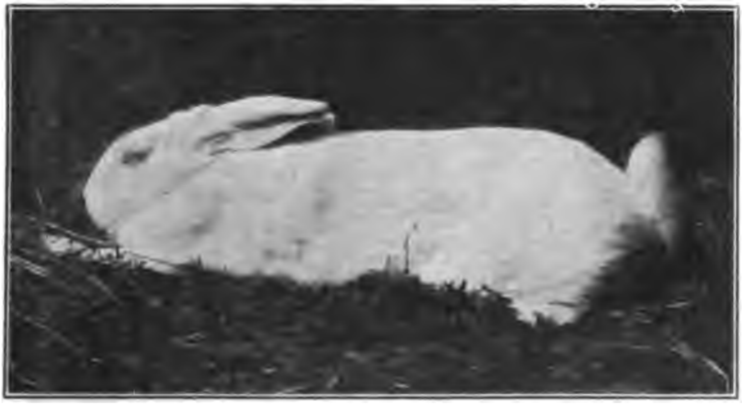

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FIG. 3.—White giant rabbit.

NEW ZEALAND REDS.

Some doubt exists about the origin of the New Zealand red rabbit. When first exhibited in California, about the year 1909, it was claimed that the animals had been purchased in a New Zealand port and brought to America by sailors. While this claim has not been disproved, it is now believed that the animals are a cross between the white giants and the rich red Belgians and that they originated in America.

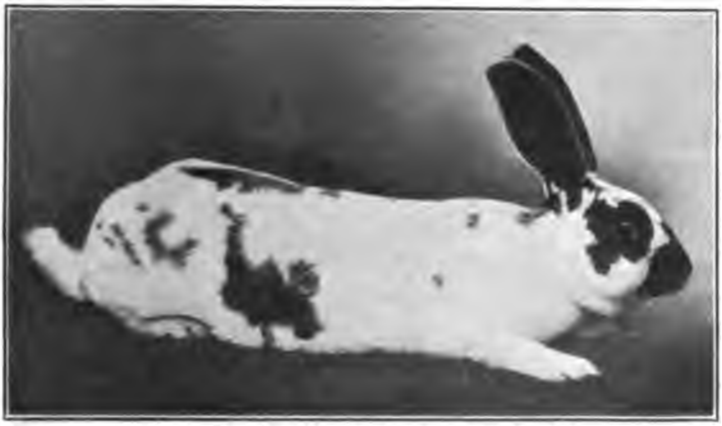

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FIG. 4.—Checkered giant rabbit.

The New Zealand red rabbit is exceedingly popular wherever it has been introduced. It is now well known in nearly all parts of the country and bids fair to become our most important utility rabbit.

Its color is a reddish buff, which should invade the hairs to the skin and be carried evenly all over the upperparts of the animal; no black hairs, darker spots, or lighter areas are desirable. The underparts should have a nearly uniform reddish cream color, blending gradually with the buff of the upperparts.

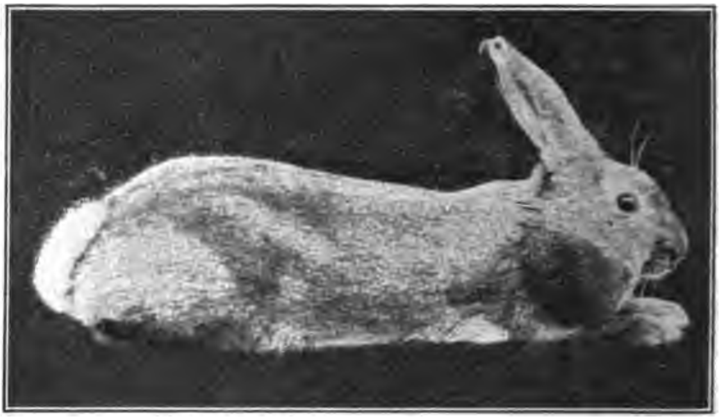

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FIG. 5.—New Zealand red rabbit.

In size the New Zealand is medium between the Belgian and the Flemish giant. It grows very rapidly, weighing 6 pounds when 5 months old, and 9 to 10 pounds when mature, at about 12 months.

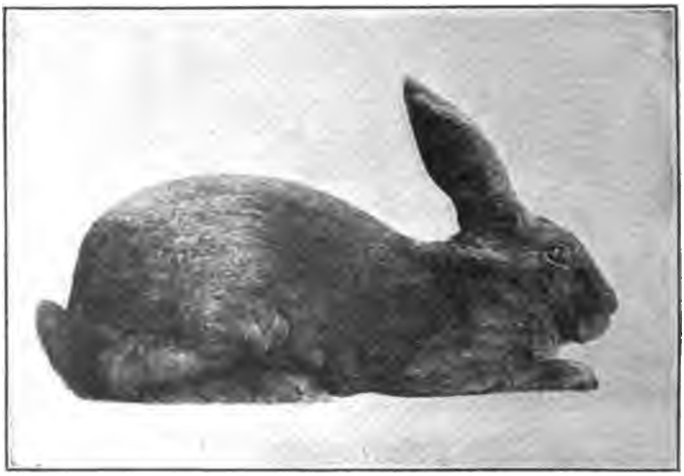

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FIG. 6.—American blue rabbit.

OTHER POPULAR BREEDS.

American blue.—The American blue rabbit, a variety recently developed in California, bids fair to become popular not only as a fancy but as a utility rabbit. No details of its ancestry or origin have been given, but it closely resembles the blue Beveran, now very popular among British breeders. The type of the California animal has been well fixed by several generations of descent, and a standard for the breed under the name "American blue" has been adopted by the National Breeders' and Fanciers' Association. The animal has short, dense fur, which seems well adapted for manufacture into cony, and the flesh is of fine quality.

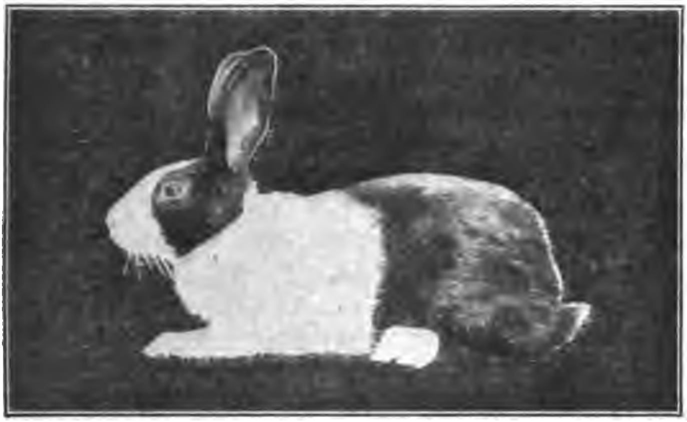

FIG. 7.—Dutch rabbit.

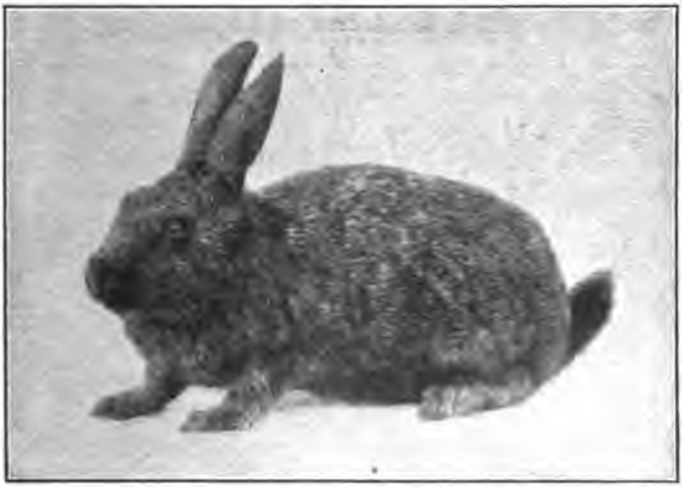

FIG. 8.—Silver-gray rabbit.

Dutch.—The Dutch rabbit, while one of the smallest breeds, is a hardy and healthy animal and is becoming quite popular in America. The does are excellent mothers and are used by many breeders of larger rabbits to nurse the young of their high-grade pedigreed stock. When a doe of a better kind gives birth to a larger litter than she can properly feed, some of the young are turned over to a Dutch doe bred at the same time, her young being removed and destroyed. Dutch rabbits are of three general color varieties, black, blue, and tortoise. The standards for distribution of color patches, size, shape, condition, and weight are the same for all colors. For the fancy, the weight should be under 5 pounds; but does of larger sizes with mixed Dutch blood will serve just as well for foster mothers in the rabbitry.

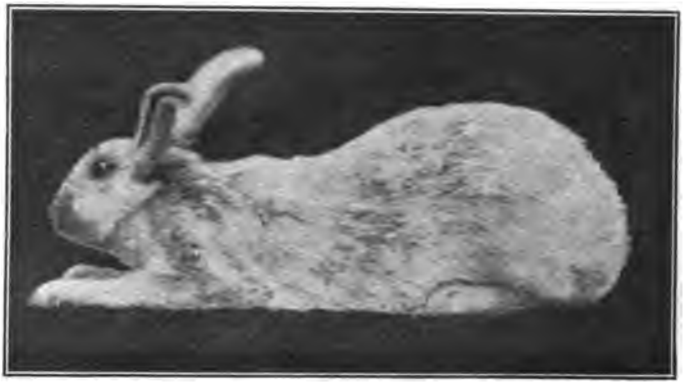

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FIG. 9.—French silver rabbit.

Silver.—The silver rabbits comprise several varieties—silver grays, silver browns, silver fawns, and also the French silver, or "Argent de Champagne." The last is the source of the best cony fur known to the trade. The standard for the grays, browns, and fawns is a rabbit under 6 pounds in weight, while for the French silver the standard demands a weight of about 8 pounds. This rabbit has thus far been bred in America only as a fancy rabbit, but when it becomes better known it will, no doubt, be popular both for its flesh and for its fur.

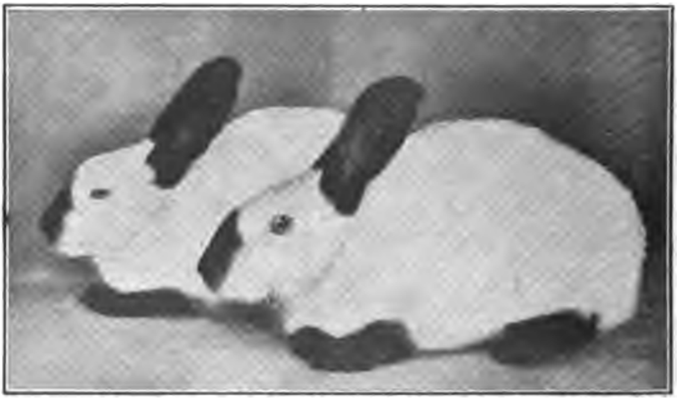

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FIG. 10.—Himalayan rabbit.

Himalayan.—The Himalayan rabbit is known chiefly as a fancy breed and is probably the most attractive variety to be seen at exhibitions of pet stock. It attains a weight of about 5½ pounds, and is pure white except on the nose, ears, feet, and tail, which should be a dense velvety black. The fur is short and dense and probably sheds less easily than that of most other rabbits. For this reason the skins of the Himalayan are in demand for making imitation of ermine, and this breed may yet come to merit the name "fur rabbit."

The breed takes its name from the fact that the first specimens shown in London were said to have been brought from the Himalayan Mountains. It is now known that these animals are not found wild in the Himalayan region and that they probably originated somewhere among European hutch rabbits. Like all other known varieties of the domestic rabbit, they are the result of selective breeding and crossing. The names Himalayan, Patagonian, New Zealand, Polish, Dutch, and Siberian, and the like are seldom properly applied as indicating the country in which the variety originated.

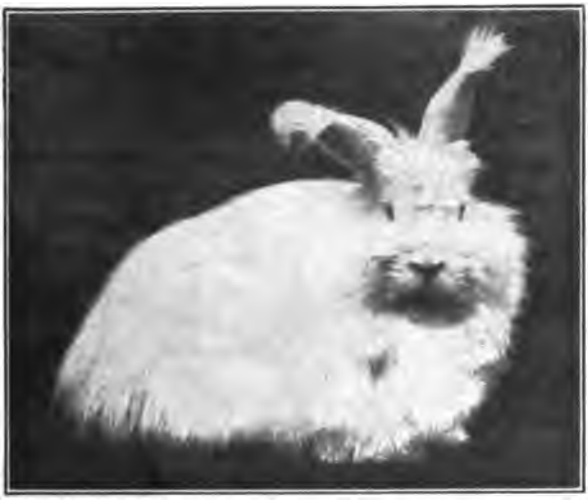

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FIG. 11.—Angora rabbit.

Angora.—The Angora rabbit is noted for its long, woolly, white pelage. This is soft and sufficiently long to be spun and woven, and it is quite possible that producing Angora rabbit wool may be profitable if it can be carried on extensively enough to support its manufacture continuously.

"Black Siberian hare."—The widely advertised "black Siberian hare" is a misnomer and has no standing among reputable rabbit breeders. The animal did not originate in Siberia, as has been claimed, but is a black giant rabbit derived from the Flemish giant, and probably had its origin in the United States. It has been bred here for many years and is regularly exhibited at shows under its true name, "black giant." When it can be bred true to its standard jet-black color, its fur is worth more than that of the other giant rabbits; but in many litters of young some are found that show a tendency to revert to gray or maltese. For this reason it has really little advantage as a fur producer over other solid-colored giant rabbits. The absurd and fraudulent claims of origin that have been made for it have been emphatically condemned by breeding associations in America.

COSTS.

The cost of starting a rabbitry depends on its size and on the price of material. One can buy two good does and a buck of breeding age —enough to supply an average family with all the rabbit meat it would care to use—for anywhere from $1.50 to $10 each, or for a total of from $4.50 to $30. Hutches for animals may vary in cost from a few cents each, the price of an empty dry-goods box, to several dollars, if expended for dressed lumber to be put together by a carpenter. On a farm where usually odds and ends of lumber and poultry netting are available, and where hay, grain, and milk are produced in abundance, the money cost of starting and carrying on a small rabbitry is negligible. In any case the initial cost need not be great.

Every breeder should keep a strict account of all items of expense and income connected with his operations. He should also know exactly what it costs to produce a pound of rabbit meat at the different ages from two months to maturity, and what is the average daily cost of feeding rabbits at different ages. The time required to do the extra work of weighing, computing, and recording results is well paid for by the certainty that one has as to whether he is gaining or losing, and how much. The daily cost, when all feed is purchased, is not usually above 1 cent for a 10 or 12 pound rabbit.

SELECTING STOCK.

The first step in selecting stock is to decide on a breed. This is chiefly a matter of taste, although it may be influenced more or less by the market that is to be supplied. For example, the family table would demand smaller animals than would the trade of a restaurant or hotel. It is best to begin with only one breed and to concentrate on developing that into stock that may be a source of pride and profit.

One buck and two or three does are enough to start with. Young animals of breeding age are better than older ones, which will soon be past their usefulness. The buck should come from a different source from the does. It is always best to deal with reputable breeders and to examine stock before buying it. When rabbits are ordered by mail, it should be on condition that they may be returned immediately if not found to be as represented. Before rabbits are accepted, they should be scrutinized to see that their ears are erect and free of canker, their eyes full and bright, and their tails and feet straight and shapely; and that they show no signs of snuffles, such as sneezing, a discharge from the nostrils, or paws soiled with mucus; and that they do not have long, coarse claws, which are a sure indication of old age.

While color is of no consequence from the standpoint of meat, well-colored animals, conforming to standard pure-bred types, are more satisfactory to most breeders than those of varied colors or shades. When possible, it is well to select bucks and does of the same shade of color and to dispose of any young animals differing from this shade. The established breeder, in selecting from his young animals those that are to be kept, should consider their form, health, disposition, rate of growth, and parentage—aiming constantly to improve his stock by selective breeding.

The rabbit industry has suffered greatly from unscrupulous advertising. Misrepresentations as to the origin of stock and as to its quality have been common, and novices in rabbit breeding have often been deceived. It has been found that firms with quarters in city office buildings and neither owning nor raising rabbits advertise stock for sale with agreements to buy back all young rabbits raised by the purchaser. The price at which their stock is offered is usually unreasonably high. An offer to buy back the young is legitimate and reasonable if only first-class and registered stock is sold and there is assurance that its high grade will be scrupulously maintained by the purchaser. The prospective breeder should be wary of "buy-back" offers, and before investing should make certain that the advertiser is responsible and has a good standing among breeders.

HUTCHES AND YARDS.

Two widely different systems of management are followed by American rabbit breeders. Under the first system, which may be called hutch management, the animals are confined in small pens or hutches and obtain little exercise. This is the more common practice and has the advantage of requiring less room and probably of producing meat more rapidly. Under the other system, rabbits are given the freedom of open yards or runs, where they obtain abundant exercise, and are sheltered in small hutches or kennels. This method promotes the general health of the animals and probably gives a better development of their fur. It is especially adapted to the southern part of the United States, where there is a mild climate throughout the year, and may be followed in the North during the summer months.

Hutches for a large breed of rabbits should have about 12 square feet of floor space and a height of 18 to 24 inches, inside measurement. If there is plenty of room in the rabbitry it is best to have the hutches separate, but to save space they are frequently built in tiers, or stacks, of two or three in height. A single hutch may be made from a dry-goods box by nailing 1-inch-mesh galvanized poultry netting over the open side. A tier of hutches may be similarly constructed from a piano box. Rabbits are more easily cared for, however, and are less likely to become diseased in well-built hutches than in extemporized ones, which become foul and unwholesome unless cleaned and re-bedded with straw, sawdust, or other absorbents very frequently. Self-cleaning hutches, such as are here illustrated, require no bedding and are easily kept in good order.

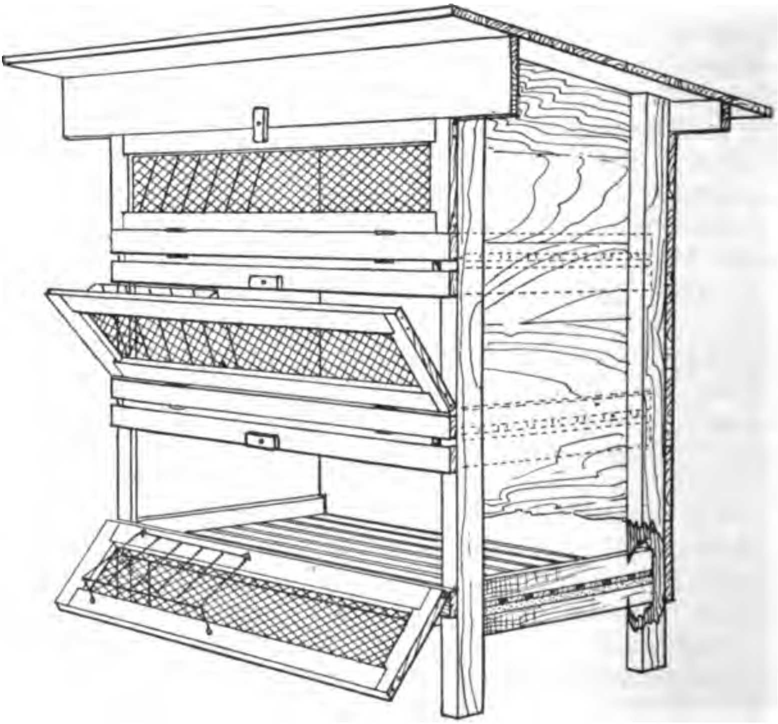

FIG. 12.—Slat-floored hutches built in a tier.

There are two general kinds of self-cleaning hutches, those with slat floors and those with slanting floors, both of which are here illustrated. Slat floors are built of 2-inch strips of board, spaced half an inch apart. Beneath each floor is a galvanized-iron pan about 1 inch deep, designed to catch droppings from the floor above. This pan is made to fit closely in order to prevent upward drafts of air. The slats forming the floors are nailed to the cross pieces above them in order to save space and allow the pan to slide close to the floor. Attached to the door of each hutch is a rack designed to contain hay or greens. The nest box for this hutch may be made of an ordinary wooden packing box about 12 inches wide, 16 inches long, and 10 or 12 inches high. Such a box needs only to have the cover left off and to be half filled with bedding. It is not necessary to cut a hole in the side for an entrance. The hutch shown in figure 12 was designed for outdoor use. For indoor use the roof may be replaced by a level top.

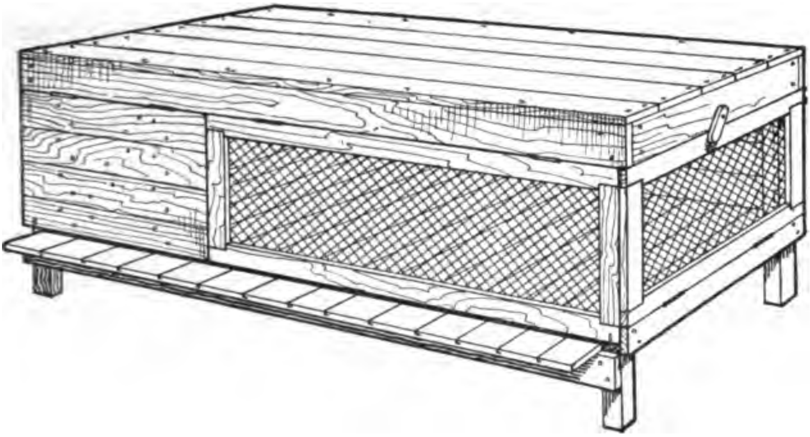

FIG. 13.—Slant-floored hutch.

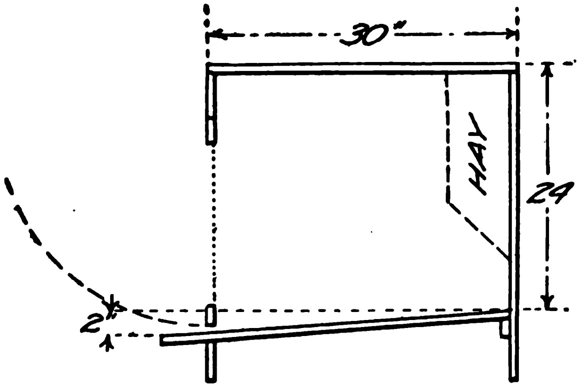

FIG. 14.—Cross section of slant-floored hutch shown in fig. 13.

Figures 13 and 14 illustrate the construction of the slanting-floor type of hutch. In this, the floor is built of dressed tongued-and-grooved lumber running crosswise of the hutch and has a slope of about 1 inch to the foot toward the front. A space of about half an inch between the floor and the side doors allows refuse from the hutch to roll beneath the doors and fall to the ground below. The end door is designed to be used in feeding the animals, while the side doors are used for cleaning or disinfecting the hutch. This type of hutch lends itself readily to the compound construction outlined in figure 15. Compound hutches in this form may be arranged so as to occupy very little space, as shown in figure 16. This arrangement permits the caretaker to feed rabbits from broad passageways and to clean the hutches from the alcoves, thus keeping the feeding and cleaning operations separate. By this arrangement 72 breeding rabbits may be kept in an area 30 feet square, each individual hutch having a floor space 2½ by 5 feet.

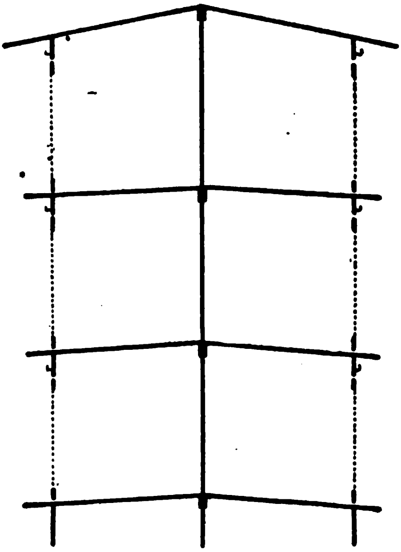

FIG. 15.—Slant-floored hutches compounded, cross section. Perspective of this type is illustrated in fig. 13.

Where one has outdoor space sufficient for the construction of runways it is well to construct yards in which young stock may get exercise. Such yards may be permanent or may consist of portable pens. Permanent yards have the fence extend into the ground 10 or 12 inches and have a height of at least 3 feet. In order to keep dogs away from the rabbits the top of the runway should always be covered with wire netting. The walls should be built of 1-inch-mesh galvanized netting, but the top may consist of 2-inch netting, which costs considerably less.

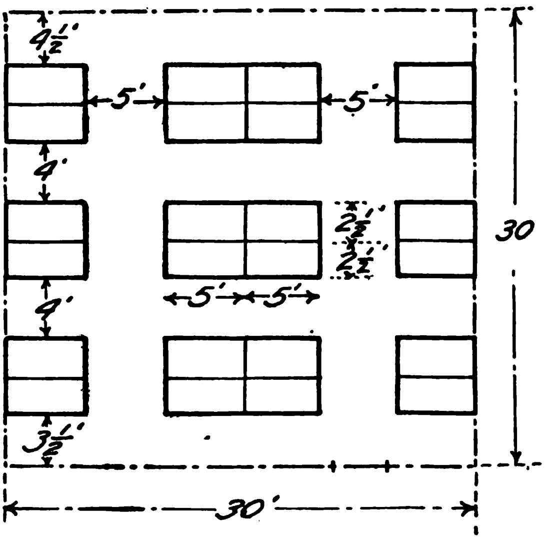

FIG. 16.—Floor plan of rabbitry.

A convenient portable pen is shown in figure 17. This may be moved about from day to day, giving the rabbits inclosed in it fresh pasturage each day and reducing the danger of disease. It will be noted that instead of extending the wire netting into the ground it is laid on the surface as a carpet. This arrangement serves quite as well to prevent rabbits from digging out as that of extending the netting into the ground. The size of this pen depends upon the width of netting used. A convenient size can be constructed of netting 4 feet wide, one strip being sufficient to cover the top and another to cover the sides and turn inward 6 inches at the bottom.

It is often convenient to combine the hutch and yard methods, using hutches for the breeding stock and a series of outdoor yards or pens for the young.

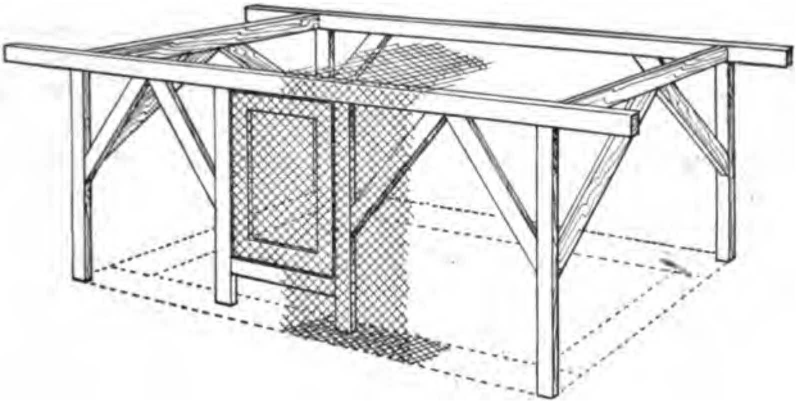

Fig. 17.—Diagram of portable pen. The wire covering extends inward 6 inches as a carpet to prevent rabbits digging out.

FEEDING.

American breeders follow no uniform system of feeding rabbits. Some feed no green stuff, while others use all that is available. It is usually wise to avoid both extremes, but green feed must be used with more caution than is necessary with dry, and only the best of any kind should be used. This means particularly that spoiled, moldy, or dirty feeds are to be avoided as injurious to rabbits. Clean oats (whole or crushed), bright well-cured hay, and a small portion of some kind of greens daily is the steady diet used in most rabbitries. Crushed barley may be substituted for oats; clover or alfalfa may be used with green oats or timothy hay; and the greens may consist of carrots, rutabagas, prunings from apple and cherry trees, and plantain, dock, burdock, dandelion, cauliflower, lettuce, or lawn clippings. Lawn clippings or other green grass should be clean and not fed when moldy or fermented. Dandelion tops and roots not only have a food value, but are useful on occasion because of their medicinal properties. A variety of feed is essential.

Warm mashes should be given daily to the nursing doe and to young rabbits for a time after they are weaned. All rabbits are benefited by warm mashes in very cold weather. Bread and milk, oat or barley meal and milk, and many other kinds of mashes may be provided. Rolled oats and bran make an excellent grain ration for the young.

The quantity of grain required by rabbits depends on their age and condition, and also on the kind and quantity of other feed they receive. Some rabbits require more grain than others. Only by noticing the condition of each animal day by day can its feed be properly regulated. Full-grown animals require less grain between than during breeding periods. They should never be allowed to become heavy with fat unless wanted for the table. Eighteen or twenty young rabbits from 3 to 5 months old having a pint of crushed oats or barley a day, in addition to plenty of dry alfalfa and greens, will grow very nicely.

Fattening rabbits for meat may begin at any time after they are 10 weeks old and should continue 3 weeks, the animals being confined in small quarters to prevent their getting too much exercise. The proportion of greens in their feed should be decreased, while that of grain should be increased. By gradually replacing half the usual grain ration with corn meal the rate of fattening can be increased.

Most breeders feed rabbits twice daily, giving greens in the morning and dry grain and warm mashes in the evening, but keep a supply of dry hay constantly before them. Rabbits that are fed two or three times a day should not be supplied with a larger grain ration than they will clean up within a short time. Water should be given every morning, but in freezing weather it should be removed when the rabbits have finished drinking. Salt should be supplied with the oats two or three times a week or a small piece of rock salt may be kept beside the feeding pan permanently. Salt bricks may be made from table salt by placing the required quantity in a paper funnel and adding to it sufficient water to moisten it. When the salt is dry it will be solid.

Hay, oats, or other coarse, dry feed should not be fed to young rabbits before they are weaned, and only limited quantities should be allowed them for a week afterward, as such feed eaten in excess causes indigestion. Too much green food is equally injurious to young rabbits during this period. Digestive troubles frequently result from overeating either class of food. Bread and milk will regulate the bowels, and an occasional feed of dandelion leaves will prove beneficial.

Cabbage leaves are not good for young rabbits and should be fed sparingly to adults kept in hutches. In open runs a larger variety of feed may be used with safety than under hutch management.

All dishes from which rabbits eat or drink should be cleaned and scalded frequently.

BREEDING.

The period of gestation of the female rabbit is about 30 days. Breeders usually raise four litters of young in a year, giving the doe a rest in July and August and again in December and January. The doe is bred early in February, having the first litter of the year early in March, and is mated again when her first litter is 6 weeks old and ready to be weaned.

When rabbits are raised exclusively for meat, five or six litters are sometimes raised in a year from one mature doe, but such intensive breeding should not be continued for more than one or two years. Younger does should then be used and the older ones discarded or bred less frequently.

The number of young in a litter varies greatly. Litters of 10 or 12 occur, but these are too large for a doe to raise. Only 6 or 7 of the best of the young should be saved. It is of advantage to have several does bred about the same time, for the number of young may then be adjusted by transferring from those having too many to those having few.

The age at which rabbits may be bred varies according to the length of time required for them to attain full size. Flemish giants are usually bred at 9 or 10 months of age, New Zealand reds at 7 or 8 months, and Belgian hares at 6 or 7 months. Small breeds, as Himalayans or silvers, may be bred at 5 months. It is not advisable to breed rabbits after they are 3 years old. Old does are generally mated with young bucks and young does with old bucks in order to increase the vigor of the progeny. The young of rabbits mated while molting are frequently rough coated and consequently unfit for show or fur purposes.

Each breeding doe must have a separate hutch for herself and young, and the buck must also be kept by himself. One buck is sufficient for 10 or 12 does. At mating time the doe should invariably be placed in the hutch of the buck. The pair should be watched to see that they really mate, after which the doe should be immediately removed to her own hutch. At the end of 10 days she should be returned to the buck, and if she then refuses his advances it may be concluded that she is pregnant.

A few days before the young are expected the hutch should be carefully cleaned and plenty of soft hay or straw placed in it. The doe will make her own nest. She should have extra feeds of warm mash to induce a good flow of milk, and a day or two after the young are born she may be removed from the hutch for a few minutes to permit an examination of the nest for determining the number of young in the litter and for removing any that may be dead. No other disturbance of the young is advisable until they are large enough to come out of the nest and run about the hutch. At this time the nest box should be cleaned and fresh straw provided.

The young may be weaned when about 6 weeks old, after which they may be kept in one hutch until 3 or 4 months old, when the sexes should be separated.

In open runs a considerable number of young female rabbits may be kept in the same inclosure until they are ready for market or for breeding. The same is true of males, unless some are unusually quarrelsome. Unruly young bucks must be separated from the others.

SELLING.[1]

The market for rabbits, both for food and for breeding purposes, should be considered well before one engages extensively in the rabbit-raising business.

Rabbits of recognized breeds, conforming in size, build, and color to the accepted standard, are usually in demand for breeding stock. Those born of registered parents are preferred and are spoken of as "pedigreed." They can be registered if the owner so desires. The cost of keeping pedigreed or registered stock is no more than that of keeping ordinary stock and the returns usually are considerably greater. If registered breeding stock is kept the best individuals can be selected and sold for breeding purposes at more attractive prices than can be obtained for ordinary animals sold for food purposes. Such stock can be disposed of, as a rule, if the home demand is not sufficient to absorb it, by advertising in poultry and pet stock journals.

A fairly good demand for domestic rabbits for food purposes has been developed in sections where rabbit raising as a business has been carried on more or less extensively for several years, while in other localities where few rabbits, if any, are raised, the meat as an article of food is little known. One should not begin raising rabbits on an extensive scale in a locality where people are unaccustomed to eating them and expect to find a ready sale for the surplus animals produced. It is much better to begin by raising a few for home use and try to develop a market gradually. Production can be increased easily as the demand and experience justify.

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[1] The section on selling rabbits was prepared in cooperation with the Bureau of Markets of the Department of Agriculture.

No breeder can expect to make much profit until he has developed a market for his rabbits. He can demonstrate the good qualities of the flesh of young rabbits to his neighbors by inviting them to dinner or by contributing the meat to supper committees to be served as salads at community sociables. Another way is to interest managers of restaurants and hotels in his product and to make arrangements with them to serve rabbits in specially prepared and advertised dishes.

If producers are not able to carry out a satisfactory campaign singly they can organize and work together. By combining they can save expenses in advertising and standardize their output. The market demands a steady and reliable supply. This can be maintained by producers cooperating much better than by individuals working separately.

Rabbits sold for food purposes usually give the greatest profit when they are 2 to 4 months old. They are marketed in three ways, (1) alive; (2) drawn, with skin, head, and feet on; and (3) drawn and skinned. If they are sent a considerable distance to market they are usually shipped alive and in crates; the second method is in many respects preferable for the general market; and the third is best when sales are made direct to consumers. When rabbits are sold dressed, care should be taken to handle them according to sanitary methods and to offer them to customers in a clean and attractive way.

DRESSING.

The best way to kill a rabbit is to stun it by striking it a sharp blow on the back of the head with a round hardwood stick and then hang it head downward and bleed it by cutting the throat. The time required by an experienced hand to skin a rabbit is less than one minute.

With a sharp-pointed knife slit from one heel past the under side of the tail to the other heel. Then twist each hind foot until the knee sticks out through the slit in the skin. Pass the fingers between the muscle and the skin to separate them and break the skin at the heel. By placing the thumb and fingers beneath the skin at the base of the tail, the bone may be pulled through them, thus stripping off the skin. It is then convenient to hang the carcass by the hamstrings as high as the operator's head, from iron pins driven 8 inches apart into a horizontal scantling. By using the knife a little around the flanks, shoulders, eyes, and lips and by severing the ears from the skull, the skin may be stripped from the body, inside out, as a glove is turned from a hand. If care is taken the skin may be removed whole, thus preserving the pelt and at the same time leaving no hairs on the meat.

Next remove the feet by breaking the bone about halfway between the first and second joints and cutting through the muscle and connective tissue. Make a lengthwise slit through the thin muscular wall over the belly, up through the cartilage of the ribs to the neck. Remove the entrails, lungs, and windpipe, reserving the heart and liver for cooking, and carefully remove the gall bladder.

After a carcass has hung in a cool place where there are no flies until its exposed surfaces are dry, a paper sack may be drawn over it and tied so as to leave the hind feet exposed, making a package that is both sanitary and convenient. For display purposes the hind feet may be cut off about an inch below the heel and one heel thrust under the hamstring of the other leg, allowing the carcass to be hung from a single peg. The appearance of a dressed rabbit may be made still more attractive by draping the fat covering the intestines across the front of the carcass.

COOKING.

The Office of Home Economics, States Relations Service, has studied the composition and digestibility of rabbit in comparison with other meats as well as the preparation for table use, and has prepared the following tables comparing the composition of rabbit and other meats and the relative weights of rabbit and chicken in the different stages of dressing and cooking.

Composition of edible portions of rabbit (Belgian hare and New Zealand red) and other meats.

Kind of meat.	Water.	Protein.	Fat.	Ash.	Fuel value per pound.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Rabbit	67.86	25.50	4.01	2.13	627
Chicken (broiler)	74.8	21.5	2.5	1.1	505
Beef:					
Hind quarter	62.2	19.3	18.3	.9	1,130
Fore quarter	62.5	18.3	18.9	.9	1,135
Veal:					
Hind quarter	70.9	20.7	8.3	1.0	735
Fore quarter	71.7	20.0	8.0	.9	710
Mutton:					
Fore quarter	52.9	15.6	30.9	.9	1,595
Leg	63.2	18.7	17.5	1.0	1,085
Pork (shoulder)	51.2	13.3	34.2	.8	1,690

In general it may be said that in composition and digestibility the rabbit closely resembles beef or other meat and poultry, but in appearance and flavor it is more like poultry and can be used in much the same way.

Comparison of live, dressed, and cooked weights of rabbits (New Zealand red) and chicken.

Condition.	Rabbit weights.		Chicken weights.	
	Lbs.	*Oz.*	*Lbs.*	*Oz.*
Live weight	5	8	5	8
Dressed (skinned, drawn, and ready to cook)	2	14	3	15
Cooked weight (meat and bones)	1	13	2	8
Loss in cooking	1	1	1	7
Weight of bones (and skin in chicken)	..	6	1	0
Weight of meat	1	7	1	8

In dressing, a rabbit loses approximately one-half of the live weight, and the chicken somewhat less, the refuse weight of the rabbit used in the experiments being 2 pounds 10 ounces, and the refuse weight of the chicken being 1 pound 9 ounces, including heart, liver, and gizzard (3 ounces), not cooked with the meat. The weight of the rabbit bones was only 6 ounces, as compared with 9 ounces in the chicken and in addition 7 ounces weight of chicken skin. The rabbit cooked in 1 hour 15 minutes and the chicken in 2 hours 30 minutes, but even then the meat of the chicken was not so tender as that of the rabbit.

In its study of the meat of the rabbit the Office of Home Economics developed the following recipes and directions:

The rabbit should be washed carefully in cold water and patted dry with a clean towel. It may then be cut into 8 or 10 pieces (if not to be cooked whole). First disjoint the legs, cutting the hind legs into two pieces each if desired, and cut the saddle into four pieces.

RABBIT SOUP.

- 1 cup concentrated rabbit broth.
- 3 cups milk.
- 4 tablespoons flour.
- 1 teaspoon salt.
- Few grains pepper.
- 1 tablespoon onion juice.

Add the milk to a broth made from rabbit bones (see rabbit pie recipe) and season with onion juice, salt, pepper, and parsley or celery leaves if desired. When it is almost boiling, stir in carefully the flour which has been moistened with part of the cold milk or with water. Stir until the soup is of a creamy consistency and serve at once.

FRIED RABBIT.

Dress rabbit, cut in pieces, dredge with flour, salt, and pepper. Heat 4 tablespoons of fat in a frying pan, drop in the rabbit, and fry slowly for 30 to 45 minutes, depending upon age of animal.

Serve with a cream gravy, using the fat in which the rabbit was fried.

FRICASSEE OF RABBIT.

Skin, draw, and wash rabbit and cut it into pieces. Dredge with flour, salt, and pepper. Brown in 4 tablespoons of fat. Change from frying pan to stew-pan, cover with boiling water, and cook slowly until tender. Remove meat from broth. Thicken broth with 1 tablespoon of flour to 1 cup of broth. Boil vigorously for a minute or two, then add dumplings, cover closely, and allow to steam 15 to 20 minutes. Pour dumplings and gravy over meat on hot serving platter.

DUMPLINGS.

2 cups flour.
4 teaspoons baking powder.
½ teaspoon salt.
1 cup milk.
1 egg.
2 tablespoons fat.

Sift together flour, baking powder, and salt. Cut in fat. Beat egg well and add to milk. Combine the two mixtures. Drop by spoonfuls into slowly boiling gravy. Cover closely and allow to steam 15 to 20 minutes.

SPICED RABBIT.

1 rabbit.
6 slices bacon.
1 medium-sized onion.
2 teaspoons salt.
¼ teaspoon pepper.
1 tablespoon cloves.

Brown sauce:
1 tablespoon sugar.
½ cup water.
1 tablespoon flour.

Skin, draw, and wash rabbit and cut it into pieces. Put it into stewpan with bacon cut into small pieces, onion cut fine, salt, pepper, and whole cloves in a bag. Cover with boiling water and cook slowly until tender.

Caramelize the sugar and add water thickened with flour well blended with 2 tablespoons of water. Pour this brown sauce over the spiced rabbit and allow the whole to simmer 2 hours.

CASSEROLE RABBIT.

8 slices bacon.
1 large rabbit cut into pieces.
2 medium-sized potatoes.
2 small onions.
2 cups hot water.
1 teaspoon salt.
¼ teaspoon pepper.

Fry the bacon until light brown and remove it from the fat. Use this bacon fat to brown the rabbit, which has been dipped in flour. Arrange in a casserole the pieces of rabbit, the strips of bacon, and sliced onions and potatoes, and dredge lightly with flour. Pour water over all. Cover and cook slowly 2 hours.

BAKED RABBIT.

1 rabbit.
3 cups cream or a thin white sauce.
6 slices bacon.
Flour for dredging.

Skin, clean, and wash the rabbit, and split it into two pieces, cutting along the backbone. Rub with salt and a little pepper, place in a roasting pan, and dredge with flour. Lay strips of bacon across the rabbit. Pour over and around it 3 cups of the white sauce or 3 cups of cream. Bake 1½ hours, basting frequently. Serve hot with the cream gravy. The liver may be boiled until tender, chopped, and added to the gravy before serving.

RABBIT IN TOMATO SAUCE.

2 tablespoons lard or butter.
3 tablespoons flour.
1½ cups tomato pulp and juice.
1 large onion chopped fine.
2 teaspoons salt.
½ teaspoon pepper.
3 cups water.
1 large rabbit.

Skin, clean, and wash the rabbit and cut it into pieces at the joints. Dip in flour and brown in a little fat.

Put the lard or butter in a deep iron skillet or a roasting pan, and stir in the flour. Add the chopped onion and the tomato juice with the seasonings and the boiling water and cook for 5 minutes. When this is boiling put in the browned rabbit. Cover and let simmer on top of stove or in the oven for one hour. The tomato sauce cooks down and gives a very good flavor to the rabbit.

RABBIT STEW WITH VEGETABLES.

1 rabbit (about 3 pounds).
4 medium-sized potatoes cut into quarters.
4 large carrots cut into cubes.
1 medium-sized or 2 small onions.
3 tablespoons flour.
2 teaspoons salt.
Few grains pepper.

Skin, draw, and wash the rabbit carefully, cut it into pieces, cover with cold water, and allow to boil slowly until almost tender. Add the potatoes, carrots, onions, or other vegetables if desired and cook until tender. Add the seasonings and flour, moistened in a little cold water. Stir until the liquid surrounding the stew is slightly thickened, and serve at once.

SAVORY RABBIT.

Skin, draw, and wash the rabbit and cut it into pieces. Dredge with 4 tablespoons of flour, 2 teaspoons of salt, and ⅛ teaspoon of pepper. Brown in 4 tablespoons of bacon or other fat. Remove meat to stew pan and cover with boiling water, and add one medium-sized onion cut in small pieces and 2 bay leaves. Cook slowly until nearly tender. To the fat that was used to brown the rabbit add 2 tablespoons of flour, mix thoroughly, and add 1 cup of vinegar. Pour this sauce over the meat and simmer until it is very tender. Serve with dumplings. This makes an excellent meal served with fresh or canned string beans and with a dessert of baked apples.

RABBIT SALAD.

To each cup of diced rabbit meat add ½ cup of celery and ¼ cup of salad dressing, ½ teaspoon of salt, and a few grains of cayenne pepper. Mix thoroughly and pour into a salad bowl lined with lettuce. Put one or two tablespoons of dressing on top and garnish with strips of green and red pepper.

Either a mayonnaise or a boiled dressing may be used for this salad.

MAYONNAISE.

1 egg, well beaten.
1 cup salad oil.
2 tablespoons vinegar.
1 teaspoon salt.
⅛ teaspoon cayenne pepper.

Beat egg constantly, add oil slowly, 1 teaspoon at a time, until egg begins to thicken. When it has thickened the oil may be added 1 or 2 tablespoons at a time until all is used. Add salt, pepper, and vinegar, and mix well. This dressing is improved by standing on ice an hour or so before using.

RABBIT PIE.

Skin and draw rabbit, cut it into pieces, put it into stewpan, and cover with boiling water. Cook until very tender. Remove meat from the broth and concentrate the broth to about one-half. Pick the meat from the bones in as large pieces as possible. Thicken stock with 1 tablespoon of flour for each cup of broth and pour over meat. Add 2 teaspoons of salt and ⅛ teaspoon of pepper. Line the sides of a baking dish with crust, add meat mixture, cover with crust, and bake in hot oven 30 minutes.

PIE CRUST.

The crust may be made in two ways—one as pie paste and the other as a rich biscuit dough.

Pie paste:

1 cup flour.
4 tablespoons fat.
2 tablespoons water.
¼ teaspoon salt.

Mix and roll as ordinary pie paste.

Rich biscuit dough:

1 cup flour.
2 tablespoons fat.
½ cup milk.
2 teaspoons baking powder.
¼ teaspoon salt.

Sift together flour, baking powder, and salt. Cut in fat and add milk to soft dough. Roll on board to one-half inch thickness and cover baking dish. This dough may also be cut as biscuits and these put on top of meat mixtures in baking dish.

RABBIT BROTH STOCK.

Crack the bones of rabbit used for pie, cover with cold water, and let simmer for 1 hour. This stock may be used for the meat stock of vegetable soup. (See also rabbit soup recipe.)

RABBIT CROQUETTES.

1½ cups milk or half milk and half rabbit broth.
6 tablespoons flour.
1 teaspoon salt.
2 teaspoons butter.
1 teaspoon onion juice or finely chopped onion.
1 teaspoon finely chopped green pepper.
Few grains pepper.
2 cups ground or chopped rabbit.

Make a white sauce of the milk, flour, butter, and seasonings. When it is thoroughly cooked remove from fire and add the ground rabbit. Cool and shape into croquettes. Roll in egg and bread crumbs and fry in deep fat or bake in a hot oven until well browned.

BAKED HASH.

2 cups coarsely chopped cooked rabbit.
2 medium-sized potatoes (diced).
1 small onion.
1 tablespoon chopped green pepper.
1 teaspoon salt.
1½ cups rabbit broth.
2½ tablespoons flour.

Place the potatoes in the boiling broth, add the onion, green pepper, and salt and let boil until the potatoes are almost done. Add the flour, moistened with a little cold water, and cook until slightly thickened. Place in casserole with alternate layers of the chopped rabbit. Cover with bread crumbs and bake until well browned over the top.

SMOTHERED RABBIT.

Put the rabbit, whole, in roasting pan, stuff (recipe given below), truss, lard with 3 strips of bacon, dredge with 3 tablespoons of flour, 2 teaspoons of salt, and ¼ teaspoon of pepper. Put 2 cups of water in pan. Allow to cook until tender and well browned, or about 1 hour. Remove the rabbit and

thicken the gravy with 1 tablespoon of flour to each cup of liquid. Into this gravy drop baking powder biscuits (directions under rabbit pie recipe) and bake uncovered until well browned.

RABBIT STUFFING.

- **2 cups bread crumbs.**
- **1 egg slightly beaten.**
- **1 teaspoon salt.**
- **¼ teaspoon pepper.**
- **1 sprig parsley cut fine.**
- **1 small onion grated.**

RABBIT SKINS.

Rabbit skins should always be saved, as they have a value, depending on their condition, and are regularly in demand. A skin may be prepared for market with less trouble than is required to bury it. It has only to be drawn, flesh side out, over a piece of thin board or No. 9 gauge galvanized wire, shaped to give it a uniform tension, and hung in a shady, well-ventilated place, as under an open shed, until it becomes bone dry. Artificial heat should not be used to dry skins if it is possible to dry them otherwise before there is danger of their becoming sour or moldy. Usually after hanging a week or 10 days skins may be removed from stretchers.

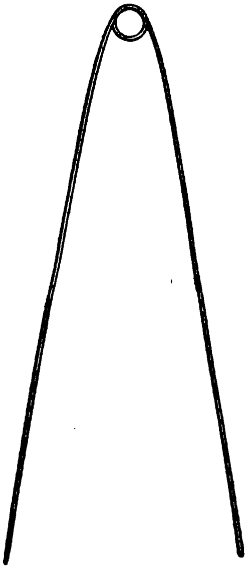

Fig. 18.—Wire stretcher to spread skins sidewise.

Figures 18 and 19 show two kinds of wire stretchers. The wire shown in figure 18 is similar to that used in making cased skins of minks, muskrats, and other small fur-bearing animals. It stretches the skin from side to side. This form is not suitable for skins that are cut or torn more or less along the under side, as it leaves the fur side of the rump exposed to the greasy surface of the skin packed next to it in the bale. The form shown in figure 19 stretches skins from back to belly instead of from side to side, thus leaving no part of the fur side exposed.

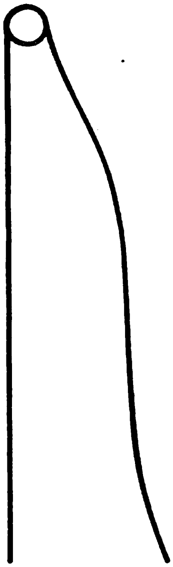

Fig. 19.—Wire stretcher to spread skins vertically.

Unless one is killing a great many rabbits, it is usually preferable to sell the dried skins to a local fur buyer, who will bale and ship for several producers. When there are a large number of skins they may be piled between upright scantlings as stove wood is piled and kept thus until enough have accumulated to make a bale. They should then be baled under lever or screw pressure, securely bound, and covered with burlap before being shipped.

If rabbit skins are intended for home use and not for sale, they may be tanned by anyone. However, amateur tanners are seldom able to secure as good results as can professional fur dressers, for the pliability of a pelt depends largely upon the amount of labor put upon it, and the furrier does this labor by the aid of modern machinery.

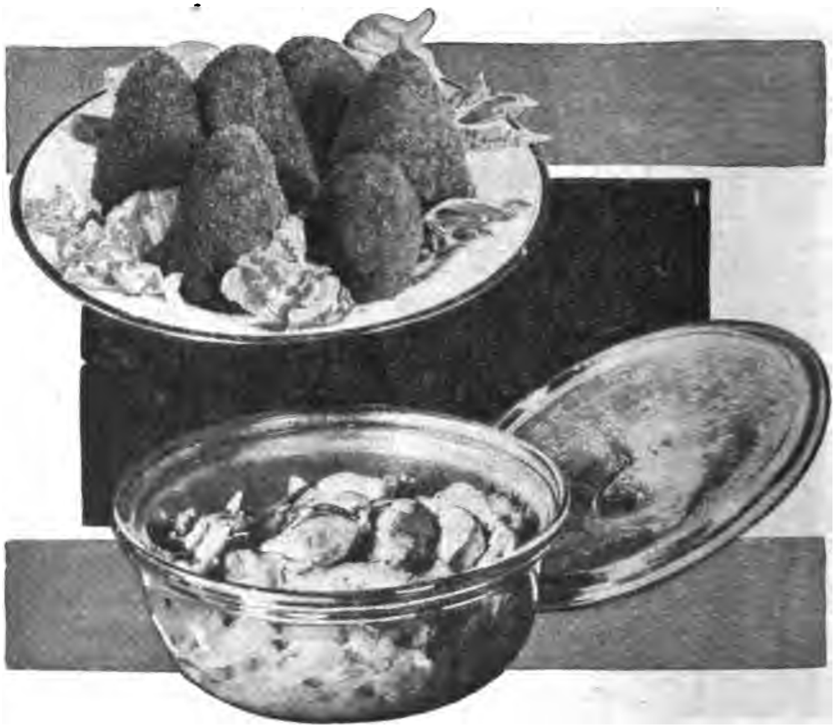

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FIG. 20.—Above, rabbit croquettes; below, casserole rabbit. See recipes, pp. 24 and 26, respectively.

For home tanning, skins should be taken off "open" instead of "cased"; or, if cased skins are to be tanned, they may be slit down the median line of the belly. The skin should be scraped on the flesh side to remove all adhering bits of flesh. Many amateur tanners are accustomed to use alum to fix the hair, but this is not recommended, as alum hardens the skin and adds to the labor required to make it pliable.

A good tanning liquor is composed of one quart of salt and one-half ounce of sulphuric acid to each gallon of water. As the acid corrodes metal, this liquid should be kept in a glass or a wooden container. Rabbit skins will be tanned in this mixture in from 3 to 4 days, but they may be kept in it for any length of time without injury..

When removed from the tanning liquor skins should be washed several times in soapy water, wrung as dry as possible, thoroughly rubbed on the flesh side with a cake of hard soap, folded in the middle lengthwise over a line, hair side out, and left to dry. When both outer surfaces are barely dry and the interior is still moist, the skins should be laid over a smooth, rounded board or plank and scraped on the flesh side with the edge of a worn flat file or other blunt-edged tool. In this way an inner layer of tissue is removed and the skins become nearly white in color. They should then be stretched, rubbed, and twisted until quite dry. If parts of a skin are still hard or stiff it should be returned to the tanning solution and the process repeated until the entire skin is soft. Fresh butter or other animal fat worked into skins while they are warm and then worked out again in dry hardwood sawdust, or extracted by a hasty bath in gasoline, increases their softness. Home-dressed skins should be matched for color before being made up into garments.

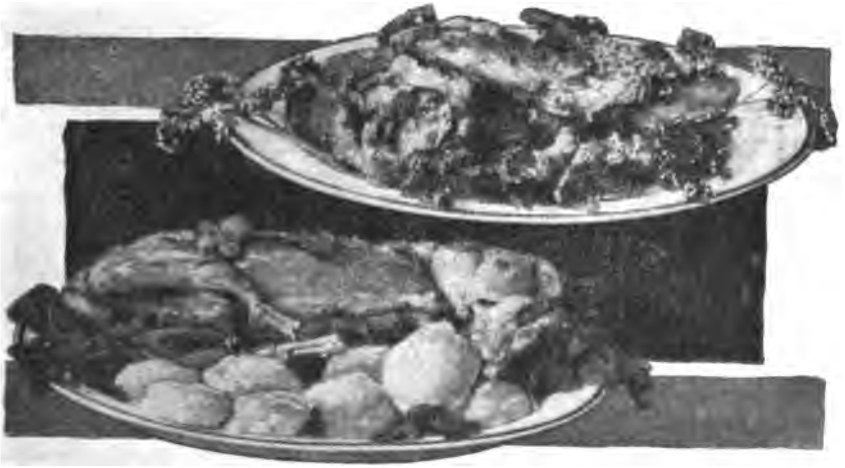

FIG. 21.—Above, fried rabbit; below, smothered rabbit. See recipes, pp. 23 and 26, respectively.

The fur from thousands of tons of dried rabbit skins is annually manufactured into felt hats. Muskrat, nutria, or beaver clippings are used for the finer grades of hats, but of the felt hats in common use, the vast majority are composed of rabbit fur that has been chemically treated to improve its felting qualities. The preparation of fur for hatters' use is a business in itself. Entire factories are exclusively devoted to it, and in the processes no part of the skin is wasted; the fur goes to hat factories, while the skins, reduced to shreds by the fur-clipping process, are made into glue, and the overhair and waste underfur are disposed of to manufacturers of fertilizer.

Before the war rabbit skins from Europe and Australia were sold here at about 12 cents a pound, or at the rate of from 1½ to 2 cents a skin. Few dealers in American rabbits cared to preserve skins for so little money. In the early days of the war, however, lack of shipping facilities reduced importations, and finally led to an embargo on furs which stopped their importation altogether. For the first time American manufacturers of hatters' furs were obliged to look to American sources for raw materials and to offer prices high enough to obtain them. The demand was supplied from wild rabbits and hares and from domesticated rabbits. Manufacturers of hatters' furs thus became familiar with American rabbit fur; buyers of raw furs became accustomed to handle it; and rabbit breeders and dealers learned that the effort necessary to prepare a cased rabbit skin is so slight as to be worth while even though the skin brings only a few cents.

Under a variety of trade names rabbit skins are largely used also for ladies' furs, the general name being "cony." White skins are known as "French ermine." Those clipped and dyed to imitate fur seal are called "near seal," "sealine," or "electric seal." Skins clipped and dyed to imitate mole fur are "cony-mole." Natural gray skins, which in the hands of expert dyers have taken on black blotches, are called "cony-leopard." Skins from young rabbits are called "kit cony."

The domesticated rabbit's skin is much thicker and stronger than that of any of the wild American rabbits or hares. Its fur breaks rather easily, although in this respect it is scarcely inferior to that of the fox or lynx, but when used as trimming for garments it is usually as durable as the fabric to which it is attached. Rabbit skins suitable for ladies' furs are worth considerably more than those fit only for making felt hats.

Many furriers think that cony is exclusively a foreign product and that the pelts of American-grown rabbits are inferior and of no value. As a matter of fact American breeders are raising the same kind of rabbits that produce the best cony of the fur shops. The climate of the United States is as favorable for the production of good fur as is that of Europe. Where American rabbit skins are of poor quality, the cause is not in breeds or climate but in management. It is possible that hutch rabbits are not so well furred as those kept in open warrens, but this has not been proved.

By adopting cooperative plans, providing uniformity as to fur-bearing varieties kept, and methods of preparing, selling, and exhibit-ing good dressed skins, breeders can do much to popularize rabbit fur. Rabbit skins now offered to the trade find a ready market, and furriers handle them on commission or buy them outright at a fair price.

DISEASES.

The diseases of rabbits are mainly due to improper feed or care. A few are contagious, and newly acquired stock should not be placed in an established rabbitry until it has been kept under observation in quarantine for two weeks. When it becomes necessary to treat a rabbit, it should be wrapped in a piece of burlap to confine its feet, as its sharp claws are capable of inflicting painful scratches. Rabbits should always be picked up by the loose skin over the shoulders, never by the feet or ears, and should be held as shown in figure 22.

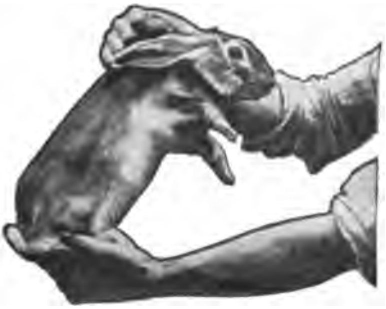

FIG. 22.—How to lift a rabbit. It should be picked up by the loose skin of the shoulders and supported as illustrated. Never pick up by feet or ears.

COCCIDIOSIS.

Coccidiosis, a disease due to a microscopic parasite, affects the intestines of young rabbits, causing diarrhea, weakness, convulsions, and death, usually at the age of 2 or 3 months. It also causes the formation of abscesses in the liver of adult rabbits but does not appear to affect their health. Coccidia expelled from the body must live outside of it for about 5 days before they are in condition to reinfect rabbits. Hutches should, therefore, be disinfected at intervals of 5 days by washing with boiling water or with a solution made by mixing 1 part cresol with 50 parts of water. Medicines have not thus far been of any avail in combating this disease. Occupied hutches should be kept as dry as possible. Water and feed dishes should be scalded daily. Droppings from infected rabbits should be disposed of where they can not possibly spread the disease.

EAR CANKER.

Ear canker is caused by one of the mange mites. It is infectious and fatal when neglected. Rabbits having ear mange, or "canker," shake their heads, flap their ears, and try to scratch inside their ears with their hind feet. Inspection shows the ear to be more or less covered by a scab. This trouble can be corrected by softening the scab with soap and water and then applying a mixture of 20 parts olive oil and 1 part carbolic acid or cresol. Several treatments are necessary to effect a cure.

INTESTINAL TROUBLES.

Disorders of the digestive organs come from feeding young rabbits too freely on wet and juicy greens, or from too radically changing their diet. Intestinal troubles may usually be corrected by a change of feed. For constipation, rabbits should have more greens and bran mash, and, if possible, more exercise. Castor oil may be administered if necessary. In a case of diarrhea, green feed should be entirely replaced by dry hay and rolled oats or barley meal. Dandelion leaves are recommended as a remedy for a disease of the kidneys evidenced by reddish-colored urine.

MANGE.

Mange is due to minute parasites which burrow into the skin, causing loss of hair and the formation of a scab. Treatment consists of cutting the hair around the scab, softening the scab with warm water and soap, and applying an ointment made by mixing 1 part sulphur with 3 parts pure lard. This ointment should be applied two or three times daily until a cure is effected. After handling a mangy animal, it is advisable to rub the hands with the ointment to prevent their becoming infected.

SLOBBERS.

When rabbits eat too much green stuff they often have indigestion, accompanied by an excessive flow of saliva running down over the chin and throat. A cure can be effected by rubbing fine salt or alum over the wet parts or by bathing them with a solution of boracic acid after they have been washed and wiped, and withholding all food for 12 hours. Milk, grain mash, and rolled oats are suitable for animals recovering from an attack of slobbers. Rabbits fed judiciously are not likely to have this disease.

SNUFFLES.

Snuffles is a very contagious germ disease resembling catarrh, which in the acute form is quickly fatal, and in the chronic form, though less malignant, seems to be well-nigh incurable. The noticeable symptoms are weakness, sneezing, and running at the nose. The nasal secretions are at first watery then thick. At the first indication of this disease steps should be taken to segregate the sick from the healthy animals. If it is necessary that one keeper care for both the sick and the healthy, he should change his clothes and disinfect his hands before attending the latter.

It is better to kill rabbits having snuffles and to burn or deeply bury the carcasses than to risk their spreading the disease through a rabbitry. It should be remembered, however, that the early symptoms of the disease are much like those of a common cold, and while rabbits having these symptoms should be isolated immediately, extreme measures should not be taken while there is any doubt as to the identity of the disease.

Affected animals should always be placed in dry, well-lighted, and well-ventilated hutches, yet where they will be protected from sudden changes of temperature. They should be fed with care; dusty hay should especially be avoided. Every possible precaution should be taken to keep the hutch clean and the feed and water dishes sterilized. If the malady turns out to be only a cold the animals that have been affected may be returned to their regular quarters when fully recovered. Hutches and buildings occupied by rabbits having snuffles must be thoroughly cleaned and disinfected.

SORE EYES.

Young rabbits are sometimes affected with sore eyes, a disease due entirely to insanitary conditions, and not found in clean, well-ventilated hutches. When adverse conditions are removed, it can be cured by using a solution made by dissolving 1 teaspoonful of boracic acid in 1 gill of boiling water, applied cold. Young rabbits should be inspected daily, and the boracic acid solution applied with a small swab of sterilized cotton at the first appearance of pus in their eyes.

SORE HOCKS.

Sore hocks may be cured by treatment with a 1 per cent solution of cresol, camphorated oil, or iodoform, and by keeping the affected animal on clean dry earth, sawdust, or straw until the sores are healed. This treatment is suitable for other sores and also for wounds. The hind feet of rabbits kept on hard floors should be examined once a week. If they become bare, the soles should be greased daily with carbolated oil, petrolatum, or mutton tallow to prevent sores.

VENT DISEASE.

An infectious disease of the external genital organs, known as vent disease, may be recognized by a swelling of the affected parts and a discharge of mucus. Rabbits having this disease should be isolated in clean, dry hutches and treated until cured by bathing with a 2 per cent solution of copper sulphate or by applying zinc ointment or mercurial ointment.

WARBLES.

Wild rabbits are often found having short, thick grubs between the skin and the flesh beneath. Occasionally these parasites are found in domesticated rabbits. They are the larval form of a fly related to the flies producing warbles in cattle, bots in horses, and screw worms in sheep. They may be removed by slightly enlarging their openings in the rabbit's skin with a sterilized knife and drawing them out with forceps. The cavity should then be treated with a 1 per cent solution of cresol.

ORGANIZATION.

Progress in all lines of industry depends very largely upon concerted action. Thus, organized clubs and associations of breeders of all kinds of animals have been formed which enable the members to hold exhibitions and public discussions, to support periodical literature devoted to their interests, and to obtain for neighborhood use breeding animals of a better grade than the average breeder is willing to buy alone. A progressive breeders' association–not only helps its members and other breeders connected with it, but encourages other people to enter the industry.

Rabbit producers, appreciating these advantages of organization, have been quick to form local and State clubs, which are usually affiliated with a national association. Such organizations are developing rapidly throughout the country and are helpful in fostering this growing industry.

The formation of boys' and girls' rabbit clubs also is encouraged by the United States Department of Agriculture through its State, county, and local leaders. By this means the members are furnished instruction, their work is supervised, and information regarding breeding stock is given them. Local club leaders keep in touch with the members and advise them as to improved methods for all branches of their work. Members keep an account of expenses and income, and their reports at the end of each year are mutually helpful.

Continued education of the public as to the delicacy of rabbit meat, supplemented by information on the best methods of breeding and raising rabbits, marketing the meat, and disposing of the fur as a by-product, is all that is needed to establish rabbit raising as a flourishing industry.

Write to the U. S. Department of Agriculture, Washington, D. C., for further information about rabbits.

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United States Department of Agriculture

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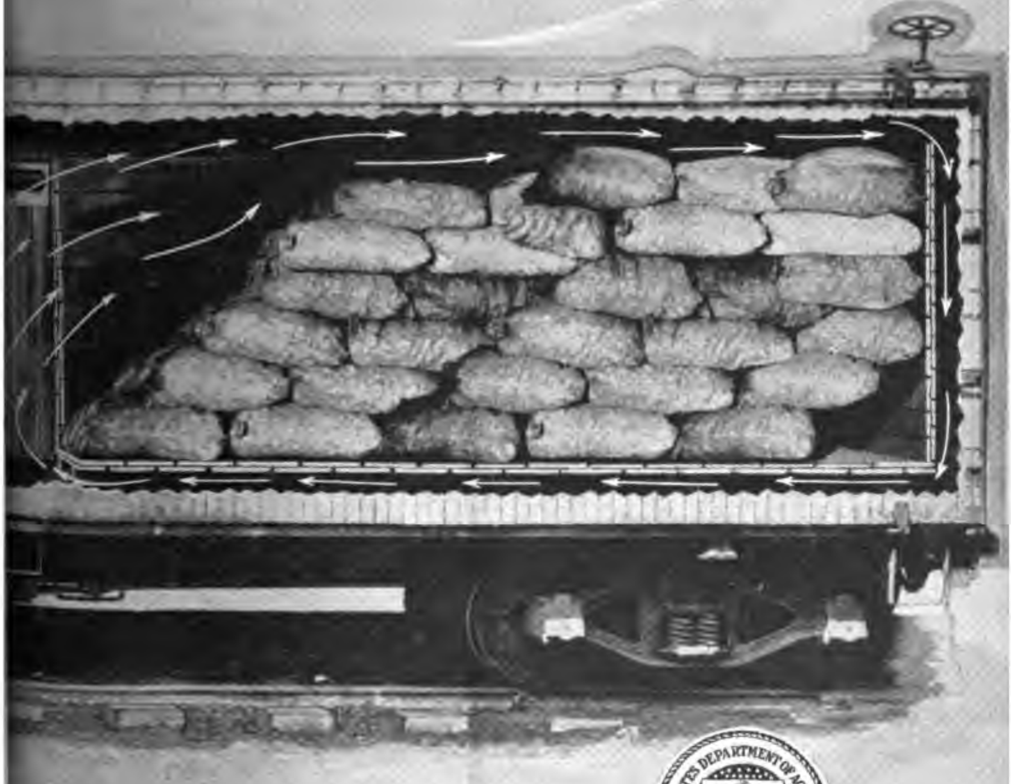
Protection of Potatoes from Cold in Transit – Lining and Loading Cars



During the winter of 1917 and 1918 approximately 75 per cent of all cars prepared to protect potato shipments from cold during the winter months were either lined or loaded incorrectly.

Protection from cold depends largely upon a constant current of warm air from the heater directly to the ceiling, spreading between the ceiling and the top potatoes, thence through openings at the opposite end of the load down to the space beneath the false floor, and from there under the false floor to the heater again.

This bulletin, which is a revision of Markets Document 17, Lining and Loading Cars of Potatoes for Protection from Cold, explains successful methods of lining and loading potatoes in box cars, produce cars, refrigerator cars, and heater cars.

Contribution from the Bureaus of Markets
GEORGE LIVINGSTON, Acting Chief
Washington, D. C. February, 1920

PROTECTION OF POTATOES FROM COLD IN TRANSIT—LINING AND LOADING CARS.

THESE RECOMMENDATIONS for lining and loading potato cars for protection of the shipments against cold are based upon commercial practices and the results of tests and inspections made by the Bureau of Markets of the United States Department of Agriculture. These were supplemented by conferences with many shippers, loaders, and railroad officials at shipping points in Maine, New York, Michigan, Wisconsin, and Minnesota, and at the markets of Philadelphia, New York, Chicago, and elsewhere. The principles here involved apply equally to cars from other shipping districts. The specific lining and loading directions, however, were designed primarily for cars with a heater in the doorway unless otherwise specified.

The investigations will be continued and supplemental recommendations resulting from them may be added from time to time.

PRESENT CONDITIONS UNSATISFACTORY.

Of 400 cars of northern potatoes examined by Department representatives during December, 1917, and January, February, and March, 1918, approximately one-fourth were lined and loaded correctly. That is to say, only one in every four was so lined and loaded that the heater could properly protect the car even under ideal firing conditions. In the remaining three-fourths, there was always the danger of overheating the potatoes at the top of the load, and at the same time allowing the potatoes at the floor to freeze.

THE BASIC PRINCIPLE.

When the cars are being prepared with linings and heaters for protection against freezing, it is important to remember that warm air weighs less than cool air. Warm air from the heater, therefore, rises directly to the ceiling over the heater and there flows and spreads out along the ceiling much as water poured into a long, flat pan flows and spreads over the bottom. If the warm air is not allowed to get down to the floor, it will pile up between the potatoes and the ceiling, and the top potatoes will become overheated and blackened at the center. At the same time, the warm air is

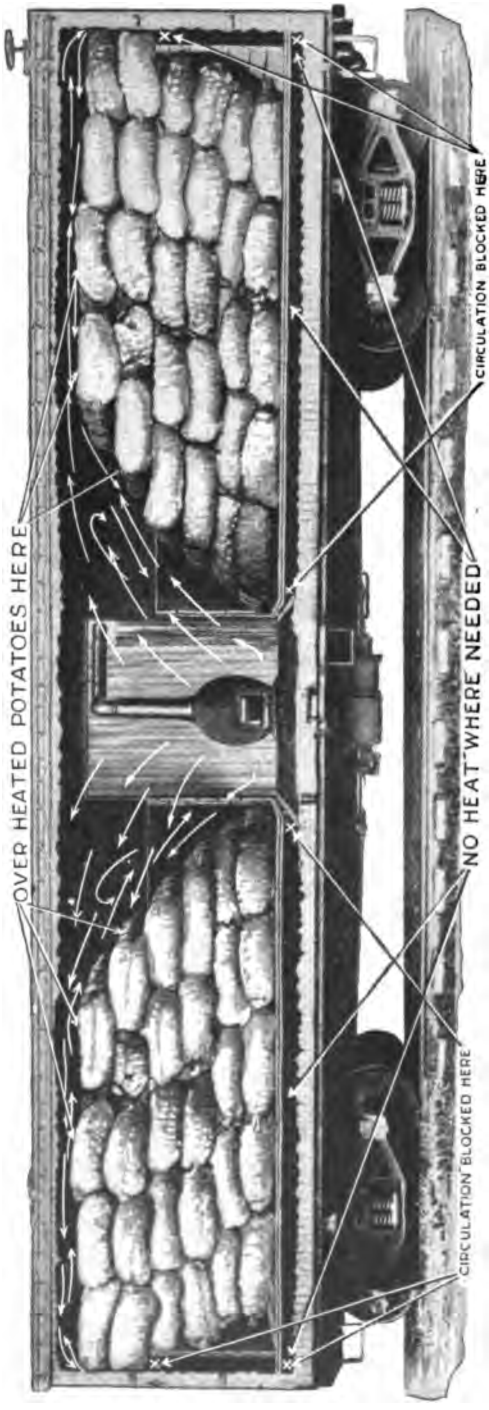


FIG. 1.—Warm air circulation in an incorrectly lined and loaded car of potatoes. The warm air from the stove can not reach the space beneath the false floor where it is needed.

kept from the floor of the car and the potatoes there may freeze. Figure 1 indicates the usual places where the circulation is blocked. It is a comparatively simple matter for a heater to furnish enough warm air to protect a car of potatoes from freezing even in severe weather, but it seems to be difficult to have the car lining built and kept in such condition that this warm air can get down to the floor where it is needed.

To accomplish this, a complete air passage the full width of the car must be kept open around the load, as shown by the cover illustration. The following points, therefore, should be borne in mind: (1) The potatoes must not be loaded close enough to the ceiling to block any part of this circulation; (2) there must be a large, unobstructed opening for the warm air to pass down to the floor after it has spread the length of the ceiling from the heater; and (3) the false floor must be so constructed that this warm air can pass under it at all points back to the heater again. This circulation is slow and labored and is limited by the smallest opening in the space provided around the load, just as the effectiveness of a chimney is limited by the narrowest place in the flue. If the chimney flue is partially blocked by soot, the fire below will not draw well. Likewise, if the space around the load is partially blocked by the potatoes themselves, or by boards, shavings, or straw, the warm air will not circulate as it should. Shippers can not make this point too clear to the employees who line and load their cars.

The following recommendations outline satisfactory methods of lining and loading the principal types of cars for the protection from cold of potatoes in transit.

BOX CARS.

ROUGH ESTIMATE OF LUMBER AND PAPER REQUIRED.

Following is an estimate of the lumber and paper needed to line an 8 by 8 foot 6 inch by 36 foot car with doors 5 feet wide:

13 pieces, 2 by 4 inches by 14 feet long.
8 pieces, 2 by 6 inches by 16 feet long.
1,300 square feet of 1-inch lumber, 16 feet long.
2,250 square feet of building paper.

Saw the 13 pieces of 2 by 4 inches by 14 feet into 26 pieces, 2 by 4 inches by 7 feet. Saw 6 inches off the length of each of the 8 pieces, 2 by 6 inches by 16 feet. Saw enough of the 16-foot boards 1 inch thick into 8-foot lengths to make a total width of 57 feet of 8-foot boards.

Saw enough of the 16-foot boards 1 inch thick into 6-foot lengths to make a total width of 4 feet. This will leave a few 4-foot lengths. Saw 1 foot off the remaining 16-foot boards, leaving them 15 feet long.

METHOD OF LINING.

1. Paper or board over all broken places, loose joints, and any ventilators or unnecessary openings in the car floor, walls, and ceiling.

2. Paper the inside of the car ceiling, walls, and floor as illustrated in figure 2. All seams should lap not less than 4 inches. All seams on the walls should be lathed, as well as those on the ceiling when it is possible to do so. The paper on the ceiling should be held in place with laths nailed to the roof supports or to a light superstructure built in when there is nothing suitable already installed. Paper should be carefully folded over all corners and lines where the floor and walls join.

Close consideration of the principles involved in papering the ceilings of box cars makes its purpose and fundamental value clear.

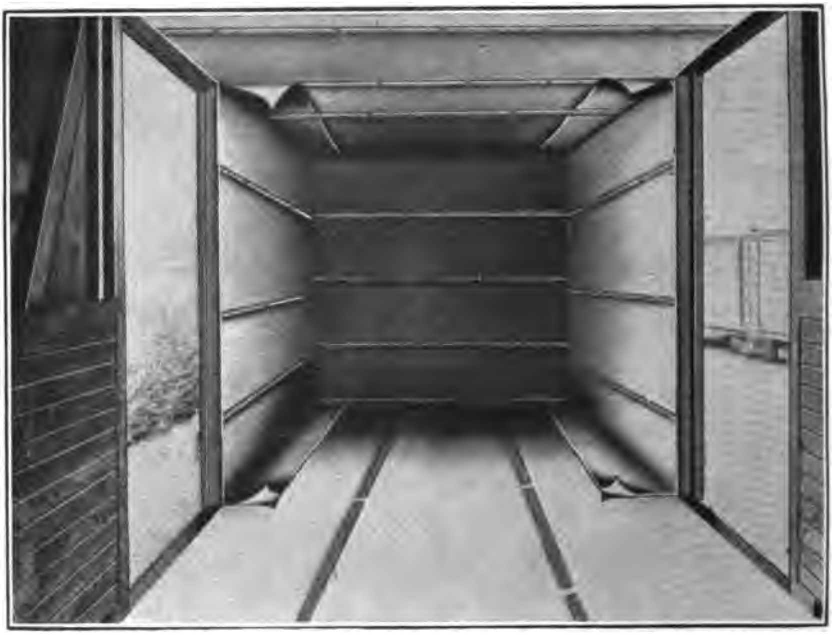


Fig. 2.—Properly papered box car. The ceiling, floor, and walls of box cars should be papered before installing the false floor and walls.

In the first place, box cars are seldom tight around the eaves and the warm air leaks out before it can pass from the ceiling to the ends of the car. It is an established fact, also, that the greater the difference in the temperature of two adjacent bodies the more rapid the loss of heat from the warmer body will be. This means that the warmth of the air in the car will be lost more rapidly at the ceiling than at the floor. This statement does not imply that the air temperature near the ceiling would become colder than that at the floor, but that the rate of loss of heat at the ceiling is greater. Inasmuch as we are dependent on the warm air at the ceiling, which later passes down the false end walls and then under the false floor, for keeping the potatoes warm at the floor, it is of vital importance that reasonable precautions be used to prevent the loss of heat.

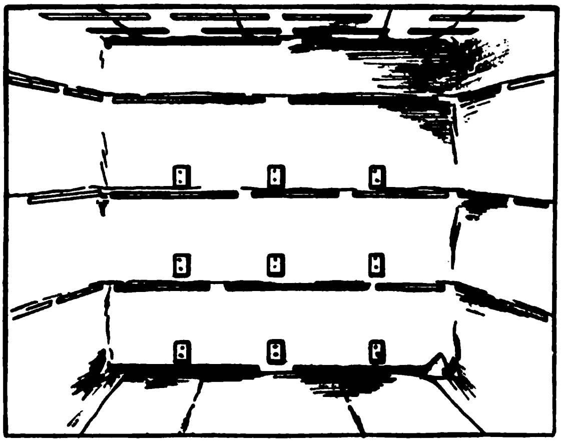


Fig. 3.—The false end wall studding blocked out from the end of the car.

3. Nail 9 blocks about 2 by 4 by 6 inches each to each end wall as illustrated in figure 3, so that when the studding is nailed to them it will leave a clear 6-inch space.

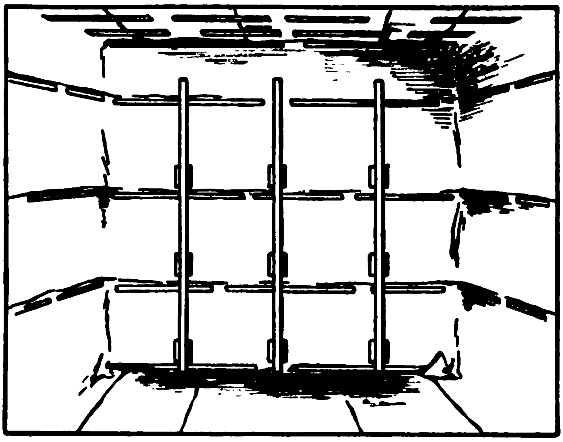


Fig. 4.—False end wall studding in place.

4. Nail 3 of the 2 by 4 inch by 7 feet pieces to the blocks as illustrated in figure 4. This will make a 6-inch space between the car end wall and the false end wall.

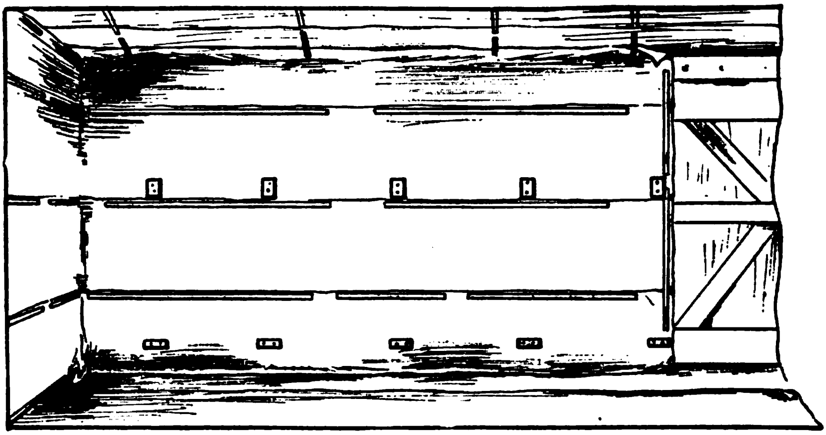


FIG. 5.—Blocks to hold the false side side wall studding from the side of the car.

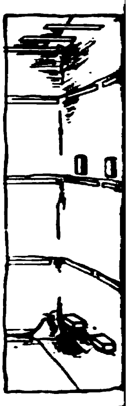


FIG. 5a.—S
view of blo
shown in fig

5. Nail 10 blocks about 2 by 4 by 6 inches each to each side of the car between the door and each end, as illustrated in figures 5 and 5a. The upper row should be nailed with the 4 by 6 inch surface against the car, and the lower row with the 2 by 6 inch surface against the car.

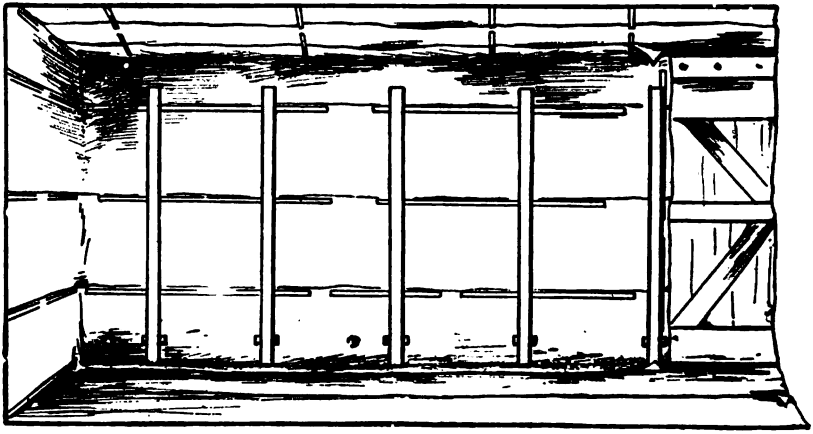


FIG. 6.—False side wall studding in place.

6. Nail 5 of the 2 by 4 inch by 7 feet pieces to the blocks as illustrated in figure 6. This will make a 4-inch space between the false side wall and the car side wall at the top row of blocks, and a 6-inch space at the bottom row.

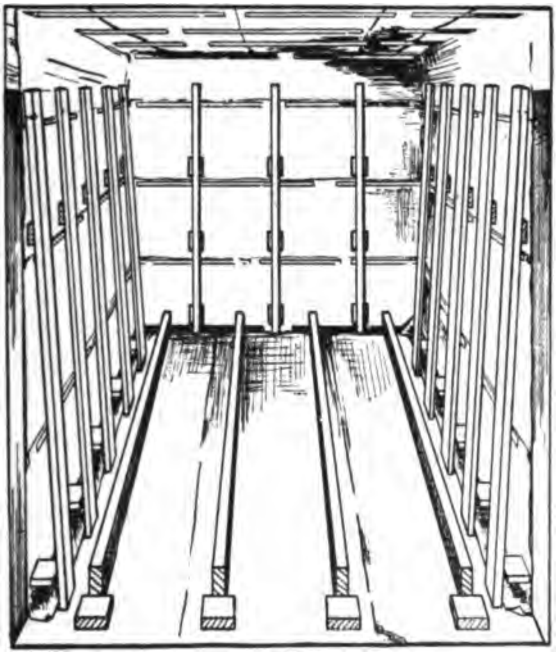


FIG. 7.—False floor stringers and blocks in place

7. Nail 4 of the 2 by 6 inches by 15 feet 6 inches pieces to the floor in each end of the car for stringers to support the false floor, as illustrated in figure 7. This will make a 6-inch space between the car floor and the false floor. Make certain that one end of the studding is tight against the end wall of the car.

8. Spike 2 by 4 by 4 inch blocks securely to the car floor at the end of each stringer as in figure 7. *Caution.*—Do not run a strip across the ends of the stringers from side to side of the car. This is a very common cause of uneven heating, as it blocks a large portion of the warm-air circulation.

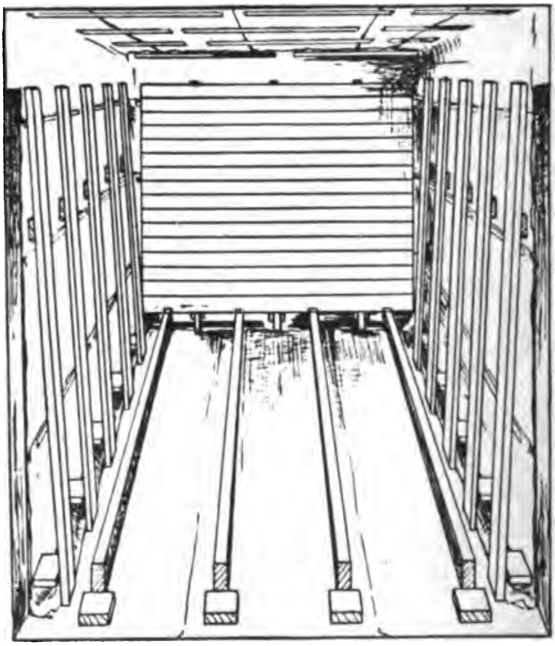


FIG. 8.—First layer of false end wall boards.

9. Nail 8-foot lengths of the 1-inch boards to the studding at the end of the car. (Fig. 8.) These boards should form a solid, tight false wall from the floor stringers to the top of the studding.

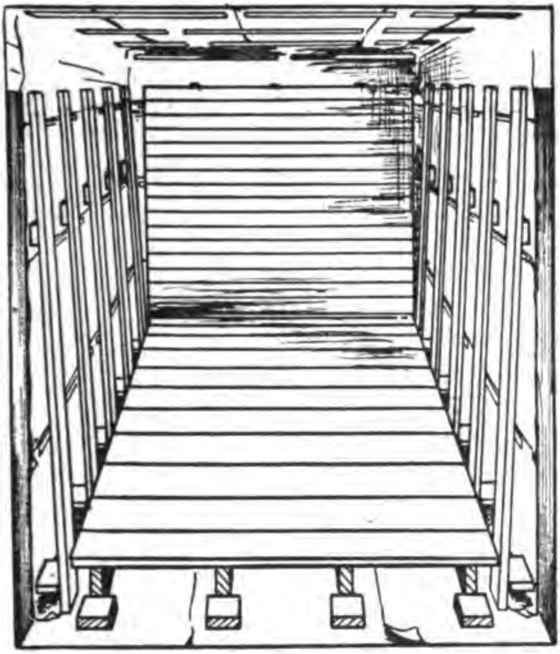


Fig. 9.—First layer of false floor boards.

10. Nail 8-foot lengths of the 1-inch boards to the false floor stringers. (Fig. 9.) These boards should form a solid, tight floor from the false end wall to the end of the stringers.

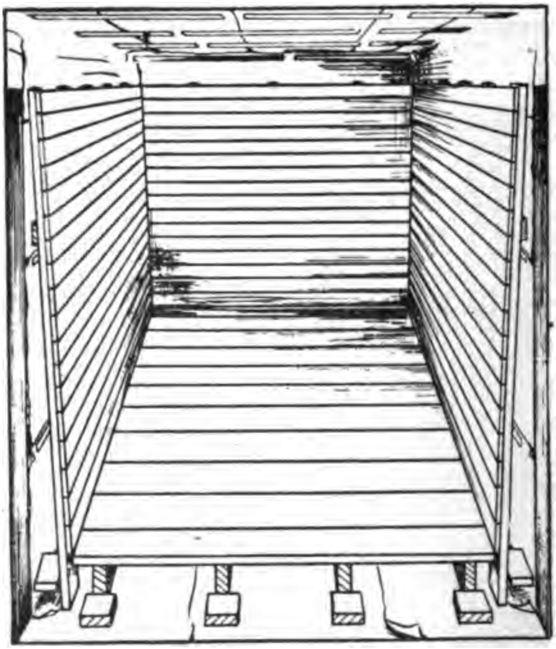


FIG. 10.—First layer of false side wall boards.

11. Nail 15-foot lengths of the 1-inch boards to the false side wall studding. (Fig. 10.) These boards should form a solid, tight, false wall from the false floor to the top of the studding.

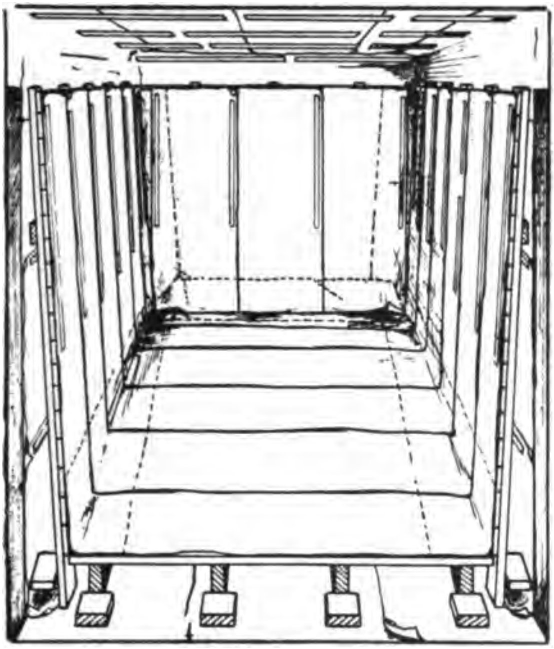


FIG. 11.—Layer of paper over first layer of false floor, side and end walls.

12. Paper the inside of the lining over the false floor and walls, lapping all seams 4 inches or more and carefully folding paper over all corners and lines where the false floor and false walls meet. Lath all seams on the false walls that come above the second layer of boards specified in paragraphs 13 and 15.

13. Nail 8-foot lengths of the 1-inch boards to the false end walls, making a tight second layer of boards from the false floor up 30 inches. (Fig. 12.)

14. Nail 15-foot lengths of the 1-inch boards on the false floor, making a tight second layer of boards. (Fig. 12.)

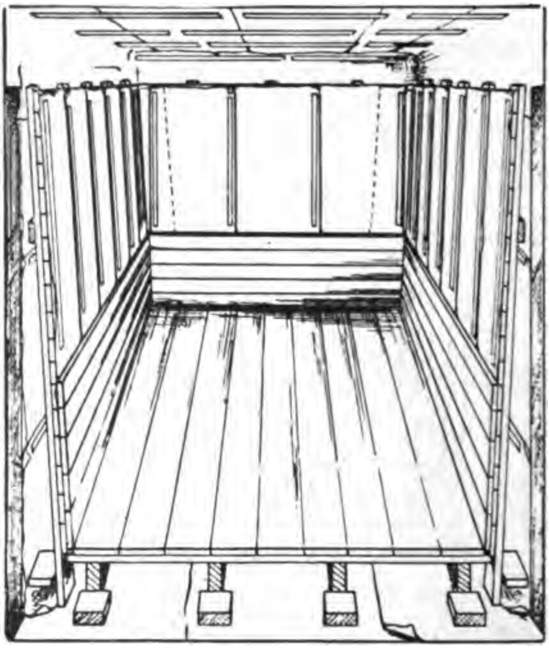


FIG. 12.—Second layer of false floor, side and end wall boards.

15. Nail 15-foot lengths of the 1-inch boards to the false side walls, making a tight second layer of boards from the false floor up 30 inches. (Fig. 12.)

16. Build in the fire door with the remaining 8 foot and 4 foot lengths, making sure that all joints are tight and that the opening for the stovepipe fits closely. If the outside temperature is freezing, it is often better that the fire door be put in and the stove set up before the false walls are installed, so that the car may be heated while the men are at work.

17. Set up the stove in the doorway, fastening it securely to the floor. Wire the stovepipe carefully in place. The regulations of each railroad should be followed in this respect.

LOADING.

18. Heat the car for at least six hours directly before loading it and longer if possible when the outside temperature and boards of the lining are extremely cold. When exceptionally warm weather conditions prevail, this is not always necessary.

19. In loading sacked potatoes they should be placed somewhat as indicated by the ilustration on the cover. At no place should the sacks in any portion of the load come closer than 8 inches to the ceiling when loaded.

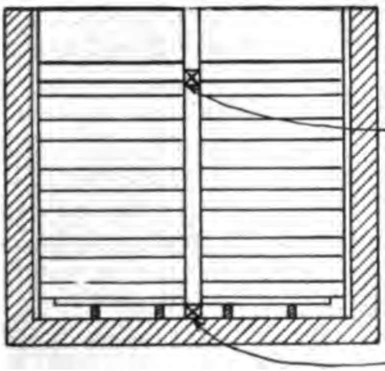


FIG. 13.—Bulkhead across car at doorway to hold bulk potatoes.

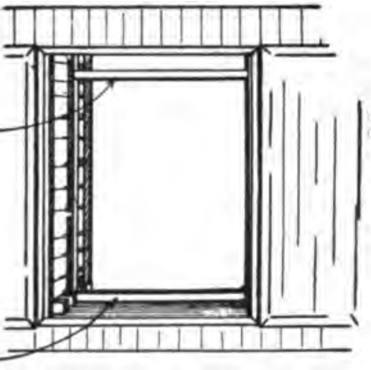


FIG. 13a.—Bracing to hold bulkheads in place.

20. In loading bulk potatoes build up the bulkhead at the doorway (Fig. 13) as necessary. The bulkheads should be made of good 1-inch boards, or heavier, so cut that they will fit and may be nailed behind 2 by 4-inch uprights nailed to each false side wall and a 4 by 4-inch upright at the center. The center uprights of the bulkhead should be braced apart with not less than two pieces of 4 by 4-inch driven in place and well nailed (Fig. 13a).

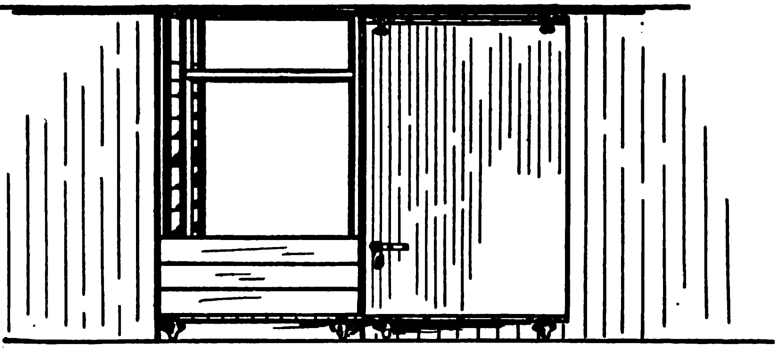


FIG. 14.—Wind boards to keep out cold winds.

21. Nail the 6-foot lengths of 1-inch boards across each door, making a solid partition from the door sill up to 24 inches (Fig. 14). Before the car is shipped it is well to fill the space between the partition and the car door with sawdust or other filler when it is not necessary to open the car door in transit. This will tend to keep out cold winds.

22. Frozen fuel should not be loaded into a car when it is possible to avoid it. Never allow frozen fuel to rest in direct contact with any potatoes. Load the fuel in such a manner that it will not block any of the circulation from beneath the false floor. This may require the use of boards laid across the floor in front of the doorway with the ends resting on the false floors. Supply abundant fuel for the trip.

23. Paper around the doors and fire board except where it will hinder the fireman from entering the car.

PRODUCE CARS AND CERTAIN OTHER INSULATED CARS IN WHICH FALSE END WALLS ARE NECESSARY.[1]

Because of the irregularity in the dimensions of cars of this type, it is impossible to give estimates for lumber required for use in all cars. The following recommendations are made:

1. All ventilator openings, broken places, loose joints, drain trenches or runways along the floor, drain pipes, etc., should be carefully plugged or otherwise boarded or papered over.

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[1] This includes all insulated cars provided with tight doors but not equipped with end ice bunkers, and also refrigerator cars with end ice bunkers, which experience has shown to be provided with so little insulation that in the opinion of the shipper it is necessary to paper over the ventilation openings through the bulkheads.

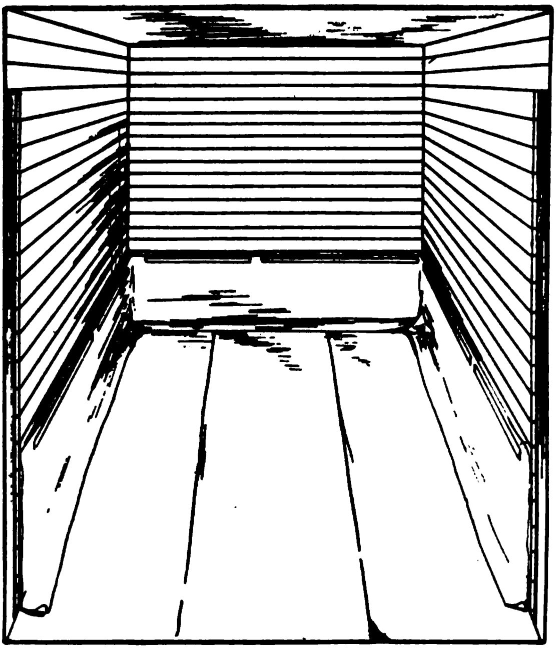

Fig. 15.—Paper the floor and the side and end walls of produce cars up 24 inches. In refrigerator cars, as provided for in paragraph 2 on page 22, the paper should not extend up the end walls.

2. Paper the car floor and walls to a height of 24 inches. Lap the seams not less than 4 inches. The paper on the walls should be held in place with lath and should be carefully folded over all corners and lines where the floor and walls join (fig. 15).

3. Nail[1] 9 blocks, 2 by 4 by 6 inch each, to each of the end walls as illustrated in figure 3, so that when the studding is nailed to them it will leave a clear 6-inch space.

3. Nail[1] 3 pieces of 2 by 4 inch studding to the blocks as illustrated in figure 4. This will make a 6-inch space between the car end wall and the false end wall. The studding should extend from the floor to about 8 inches from the ceiling.

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[1] See footnote at bottom of page 23 under paragraph 3 describing the method of preparing refrigerator cars.

5. Nail four pieces of 2 by 6 inch studding to the floor in each end of the car for stringers to support the false floor, as illustrated in figure 7. This will make a 6-inch space between the car floor and the false floor. Make certain that one end of the studding is tight against the car end wall. The stringers should extend from the end wall of the car to about even with the doorposts.

6. Nail 2 by 4 by 4 inch blocks securely to the car floor at the end of each stringer (fig. 16), or nail 2 by 4's running lengthwise of the car across the doorway, the ends fitting tightly between two or more pairs of the false floor stringers (figs. 17 and 18). *Caution.*—Do not run a strip across the ends of the stringers from side to side of the car. This is a very common cause of uneven heating, as it blocks a large portion of the warm air circulation.

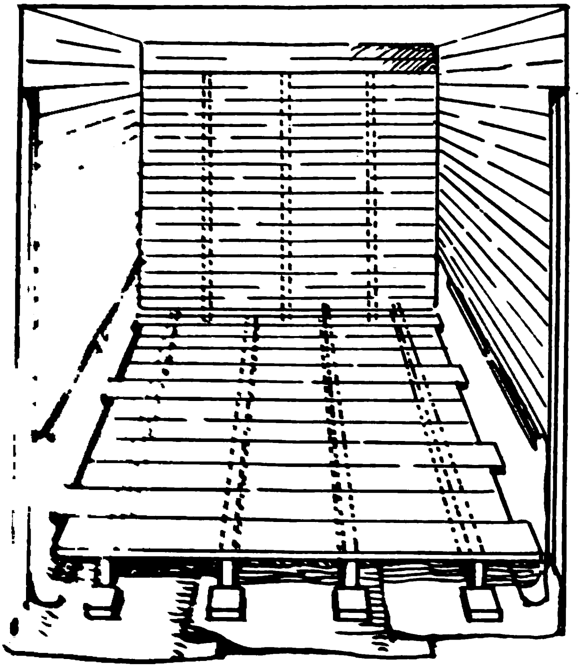


Fig. 16.—False floor [illegible] of paragraph 8) and end wall in produce car.

7. Nail boards to the studding at the end of the car (fig. 16). These boards should form a solid, tight false wall from the floor [illegible] to the top of the studding and should extend to about 8 inches [illegible]. If the potatoes are to be shipped in bulk, [illegible] tightly against the car side walls (fig. 16).

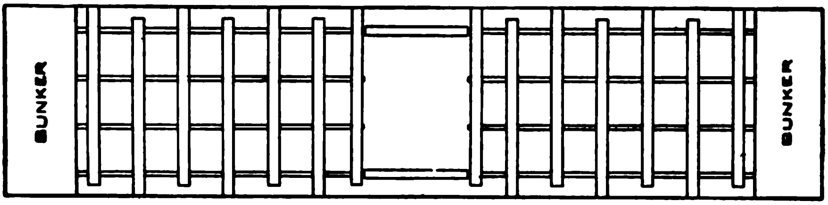


FIG. 17.—False floor supports (option (*a*) of paragraph 8).

8. (*a*) Nail sufficient 1-inch boards, or thicker, across the stringers (fig. 17), spaced to support the false floor; or (*b*) make the false floor entirely of one layer of boards crosswise on the stringers as illustrated in figures 16 and 18, in which case no space should be left between the boards. Cars already equipped with 4-inch false floors with stringers running lengthwise do not require, of course, any additional false floor.

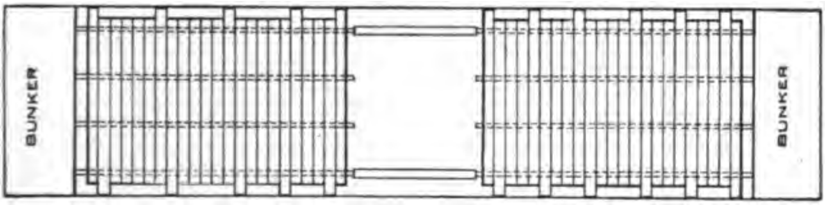


FIG. 18.—False floor (option (*b*) of paragraph 8).

9. If option (*a*) in paragraph 8 above is used, nail lengths of 1½ inch boards on the supports (fig. 17), making a tight, false floor from the false end wall to about even with the doorposts.

If the potatoes are to be shipped in bulk, the false end walls must fit tightly against the car side walls (fig. 16).

10. Paper the inside of the lining over the false floor and the side walls to a height of not less than 24 inches, lapping all seams 4 inches or more and carefully folding paper over all corners and lines where the false floor and walls meet.

11. Fire doors should be carefully fitted and made tight by the use of burlap or paper. It is recommended that the door to the left, when facing the car from the outside, be the one to be replaced by the fire door. The fire door should then be built on the inside. This will permit the right-hand door to be opened and closed, and the car may be entered from either side. If this is done, it is necessary to use burlap along one side of the fire door to make a tight joint with the car door when it is closed. If the outside temperature is freezing,

it is often better for the fire door to be put in and the stove set up before the false walls are installed, so that the car may be heated while the men are at work.

12. Set up the stove in the doorway, fastening it securely to the floor. Wire the stovepipe carefully in place. The regulations of each railroad should be followed in this respect.

13. Heat the car for at least six continuous hours directly before loading, and longer if possible when the outside temperature and boards of the lining are extremely cold. When unusually warm weather conditions prevail this is not always necessary.

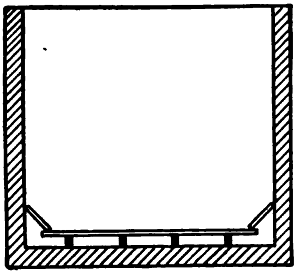


FIG. 19.—Boards to keep the bottom potatoes away from the sides of the car. This greatly reduces damage by freezing.

14. The potatoes at the floor should be loaded not less than 6 inches away from the sides and ends of the car. In bulk potato shipments, this may be accomplished by boards not less than 10 inches wide or by racks placed at an angle along the walls with one edge nailed to the false floor and the other resting (not nailed) on the side of the car. (Fig. 19.) In sacked potato shipments the same method may be used, or the bottom layer of sacks may be loaded away from the sides and ends of the car and held in place by the layers above. This method is illustrated in figure 20.

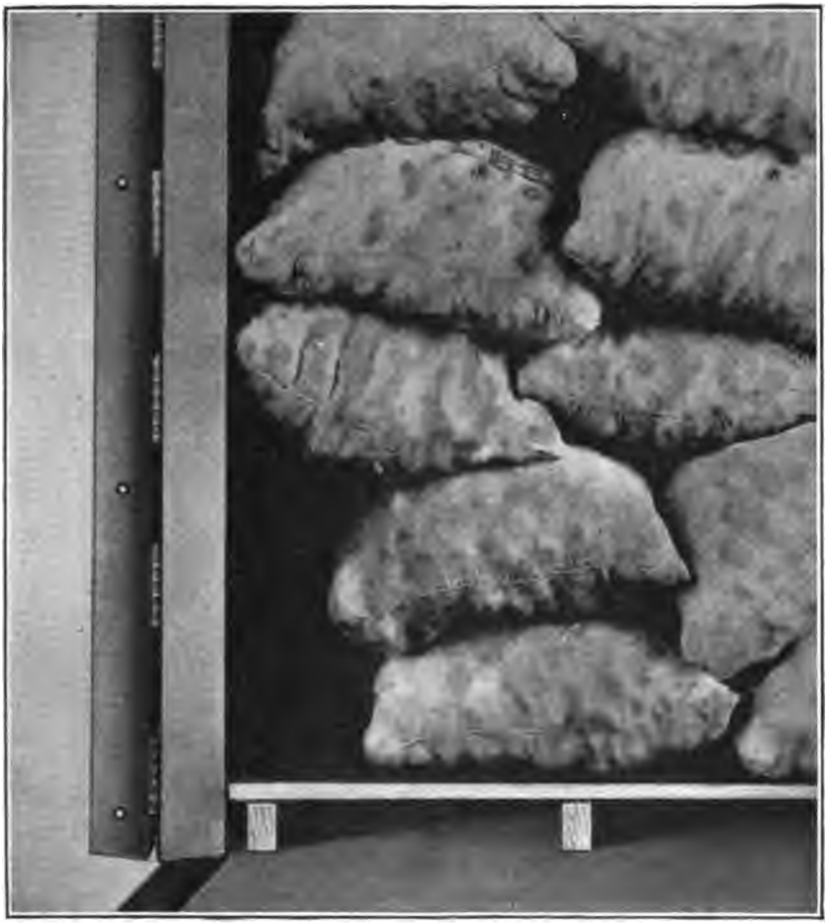


FIG. 20.—Sacked potatoes loaded away from the sides of the car to prevent freezing.

15. Load potatoes in sacks somewhat as indicated by the cover illustration and figure 20. At no place should the sacks in any portion of the load come closer to the ceiling than 8 inches when loaded.

16. In loading bulk potatoes, build up the bulkheads at the doorway (fig. 13), as necessary. The bulkheads should be made of good 1-inch boards, or heavier, so cut that they will fit and may be nailed behind 2 by 4 inch uprights nailed to the doorposts and a 4 by 4 inch upright at the center. The center uprights of the bulkheads should be braced apart with not less than 2 pieces of 4 by 4 inch studding driven in place and well nailed (fig. 13a).

17. Frozen fuel should not be loaded into a car when it is possible to avoid it. Never allow frozen fuel to rest in direct contact with any potatoes. Load the fuel in such a manner that it will not block any of the circulation from beneath the false floor. This may require the use of boards laid across the floor in front of the doorway with the ends resting on the false floors. Supply abundant fuel for the trip.

18. Paper around the doors and fireboard except where it will hinder the fireman from entering the car.

REFRIGERATOR CARS.

(EXCEPT AS PROVIDED FOR UNDER "PRODUCE CARS, ETC.", OR UNDER "INSULATED CARS SHIPPED WITHOUT HEATERS.")

1. All ventilator openings, broken places, loose joints, drain pipes, etc., should be carefully plugged or otherwise boarded or papered over, except that when oil heaters are used the drain pipes may be left open.

2. Paper over the floor and side walls, but not over the end walls, to a height of not less than 24 inches with heavy paper (fig. 15), except when prevented by permanent false floors which are hinged or fastened to the car. Paper on the side walls should be held in place with lath. The sheets should lap not less than 4 inches and be folded carefully over all corners and lines where the floor and side walls meet. In no case should any of the bunker bulkhead openings be papered over or otherwise blocked, except where false end walls are used as provided for under "Produce cars, etc.", or "Insulated cars shipped without heaters."

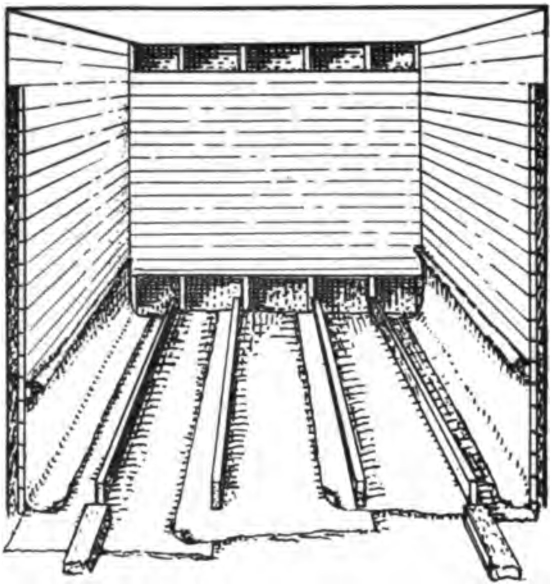


FIG. 21.—False floor stringers in place in well-constructed refrigerator car.

3. Lay four pieces of 2 by 4 inch studding on the floor in each end of the car for stringers, the 2-inch side against the floor. (Fig. 21.) Do not nail these to the floor.[1] The stringers should be evenly spaced parallel to the sides of the car with one end tight against the ice bunker bulkheads. The two outside stringers at each end must be in the same straight line.

4. Fit a 2 by 4-inch piece as a brace between each of the two sets of stringers described in the last sentence of paragraph 3. (Figs. 17, 18, and 21.) These braces should be laid with the 4-inch side flat on the floor and the ends securely toe-nailed to the stringers. Do not nail these to the floor.

5. Nail good 1-inch boards, or heavier, across the stringers, making a solid false floor from the door posts to within 6 inches of the ice-bunker bulkheads. (Fig. 18.) It is important that this 6-inch space between the ends of the false floors and the bulkheads be left. This is shown in figure 22. Each board must be well nailed to all four stringers to keep them from turning on side. At least occasional boards must extend to each side wall to keep the false floor from shifting sidewise.

---

[1] The new refrigerator-car equipment of the country is of generally very good construction and well insulated. Driving nails through the car floors, walls, or ceilings destroys the insulation. Such practices can not be condemned too severely. A high-grade refrigerator car represents a large initial and upkeep cost, and it transports perishable produce of a much greater value annually. The carriers and shippers must cooperate to save this high-grade equipment. The obligation is mutual and is a moral one.

6. Fire doors shall be carefully fitted and made tight by the use of burlap or paper. It is recommended that the door to the left, when facing the car from the outside, be the one to be replaced by the fire door. The fire door should then be built on the inside. This will permit of opening and closing the right-hand door, and the car may be entered from either side. If this is done, it is necessary to use burlap along one side of the fire door to make a tight joint with the car door when it is closed. If the outside temperature is freezing, it is often better that the fire door be put in and the stove set up before the false walls are installed, so that the car may be heated while the men are at work.

7. Set up the stove in the dorway, fastening it securely to the floor. Wire the stovepipe carefully in place. The regulations of each railroad should be followed in this respect.

8. Heat the car for at least six continuous hours directly before loading, and longer if possible when the outside temperature and boards of the lining are extremely cold. When unusually warm weather conditions prevail, this is not always necessary.

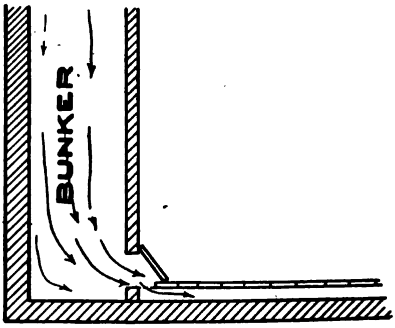


FIG. 22.—Keep this space open.

9. The potatoes at the floor should be loaded not less than 6 inches away from the sides and ends of the car. In bulk potato shipments this may be accomplished by boards not less than 10 inches wide, or by racks placed at an angle along the walls with one edge nailed to the false floor and the other resting (not nailed) on the side of the car. (Fig. 19.) In sacked potato shipments the same method may be used, or the bottom layer of sacks may be loaded away from the sides and ends of the car and held in place by the layers above. This method is illustrated in figure 20. *Caution.*—Where boards are

used to give this protection at the bulkheads, care must be taken to leave the opening for ventilation 4 inches in the clear from the bunker through the ventilation opening and under the false floor. (Fig. 22.)

10. Load potatoes in sacks somewhat as indicated by the cover illustration and figure 20. At no place should the sacks in any portion of the load come closer to the ceiling than 8 inches when loaded.

11. Load bulk potatoes, building up the bulkheads at the doorway (fig. 13) as necessary. The bulkheads should be made of good 1-inch boards, or heavier, so cut that they will fit and may be nailed behind 2 by 4 inch uprights nailed to the doorposts and a 4 by 4 inch upright at the center. The center uprights of the bulkheads should be braced apart with not less than two pieces of 4 by 4 inch, driven in place and well nailed. (Fig. 13a.)

12. Frozen fuel should not be loaded into a car when it is possible to avoid it. Never allow frozen fuel to rest in direct contact with any potatoes. Load the fuel in such a manner that it will not block any of the circulation from beneath the false floor. This may require the use of boards laid across the floor in front of the doorway with the ends resting on the false floors. Supply abundant fuel for the trip.

13. Paper around the doors and fire board except where it will hinder the fireman from entering the car.

INSULATED CARS SHIPPED WITHOUT HEATERS.

Comparatively short-haul potato shipments without the use of heaters are made in certain sections. This method should be adopted only in high-grade refrigerator cars in good condition.

The cars should be prepared as are refrigerator cars, except for the heater and fuel. If there is any possibility that the car may have to be heated later, the space beneath the false floor should be kept clear from all obstructions and the ventilation openings through the ice-bunker bulkheads should not be papered over.

In addition to these precautions the following recommendations are made:

1. Heat the car for a period of not less than 12 hours directly before loading, except when unusually warm weather conditions prevail.

2. Use not less than two heavy layers of straw with alternate layers of building paper for added insulation between the potatoes and the false floor and between the potatoes and car walls.
3. Ship potatoes in this way only when favorable temperature and weather conditions prevail.

CARS WITH HEATERS PERMANENTLY INSTALLED.

Certain of the heater cars in use protect potato shipments from the cold quite satisfactorily. It is expected that the future will bring great improvements in this class of railway equipment.

Heaters permanently installed as a part of the car equipment can have the decided advantage of applying the heated air from beneath the car directly to the space beneath the false floor where it is needed, while with the temporary heaters in use the heated air must first pass to the ceiling before circulating down to the floor. These cars come with false floors and walls installed and are ready for loading. At the present time their use for potatoes in the United States is restricted mostly to shipments from Maine, Wisconsin, Minnesota, North Dakota, and Washington.

Approximately the same rules should be used in loading these cars as in loading refrigerator cars.

CAR-LOADING DOCUMENTS OF THE U. S. BUREAU OF MARKETS.

Factors in Transportation of Strawberries from the Ozark Region. Markets Doc. 8.

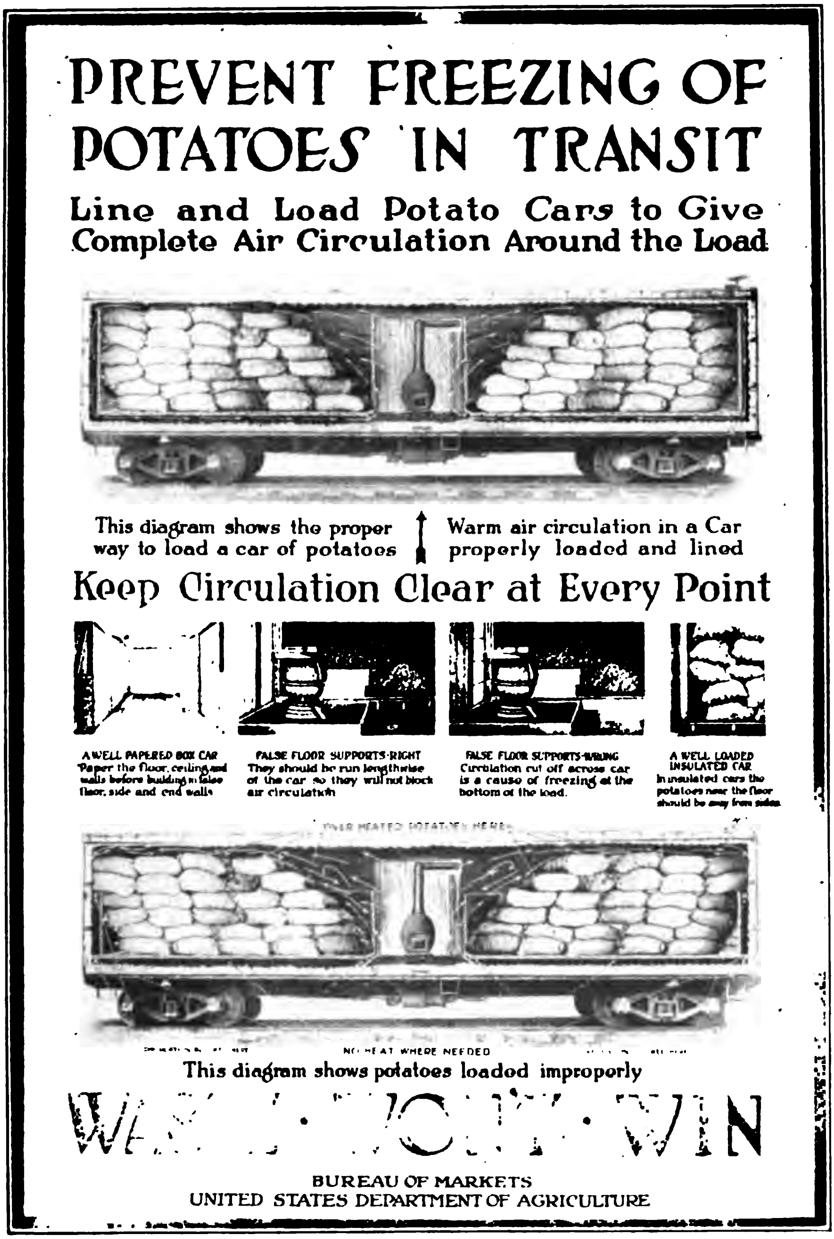
Loading and Transporting Western Cantaloupes. Markets Doc. 10.

Heavy Loading of Freight Cars in the Transportation of Northwestern Apples. Markets Doc. 13.

Loading American Grapes. Markets Doc. 14.

Handling and Loading Southern New Potatoes. Farmers' Bulletin 1050.

Copies of these documents may be had as long as available supply lasts by application to the Division of Publications, United States Department of Agriculture, Washington, D. C.



PREVENT FREEZING OF POTATOES IN TRANSIT

Line and Load Potato Cars to Give Complete Air Circulation Around the Load

This diagram shows the proper way to load a car of potatoes

Warm air circulation in a Car properly loaded and lined

Keep Circulation Clear at Every Point

A WELL PAPERED BOX CAR
Paper the floor, ceiling and walls before building in false floor, side and end walls

FALSE FLOOR SUPPORTS-RIGHT
They should be run lengthwise of the car so they will not block air circulation

FALSE FLOOR SUPPORTS-WRONG
Circulation cut off across car is a cause of freezing at the bottom of the load.

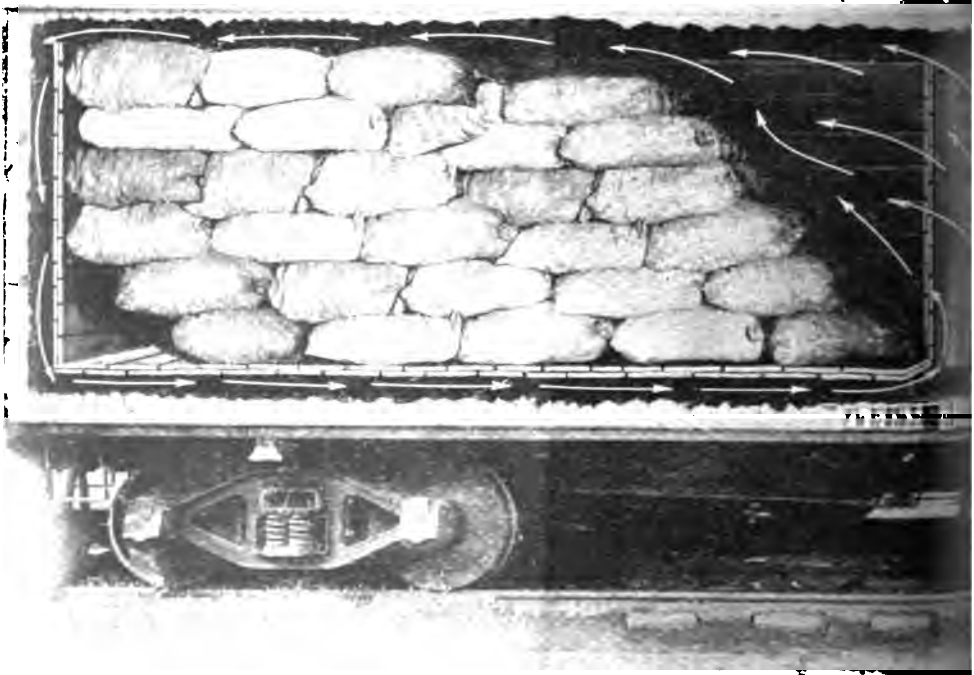
A WELL LOADED INSULATED CAR
In insulated cars the potatoes near the floor should be away from sides

This diagram shows potatoes loaded improperly

W[illegible]IN

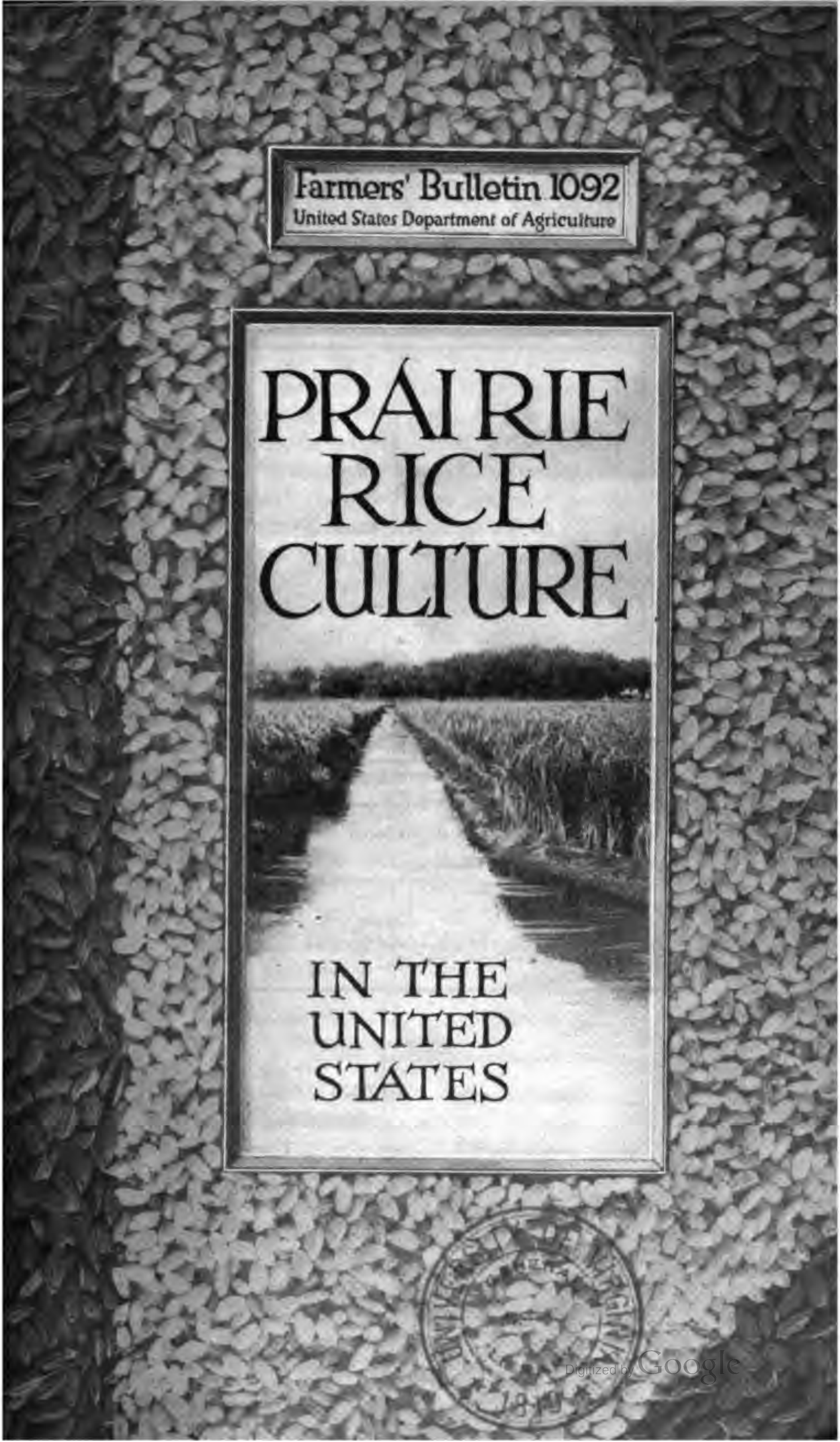
BUREAU OF MARKETS
UNITED STATES DEPARTMENT OF AGRICULTURE

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920



Farmers' Bulletin 1092

United States Department of Agriculture



PRAIRIE RICE CULTURE

IN THE UNITED STATES

RICE produces its largest yields on clay soils that are not too deficient in organic matter. The land selected for rice culture should lie in level tracts that can be cheaply drained.

The crop requires an abundant and always available supply of fresh water, and to obtain good yields of high-grade rice ample drainage facilities must be provided.

The surface soil of the seed bed should be loose and finely pulverized to a depth of at least 2 inches.

The field levees should be low, broad, and permanent and constructed on contour lines at distances which will hold the water at an average depth of 5 inches. They also should be seeded to rice. This will increase the cultivated area and leave no uncultivated strips in the field for the growth of weeds.

The harvested rice should be put into strongly built shocks that should be well capped to protect the grain from the sun as well as from the rain. Thrashing should not be done until the rice has remained in the shock for at least two weeks.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. February, 1920

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PRAIRIE RICE CULTURE IN THE UNITED STATES.

CHARLES E. CHAMBLISS,
Agronomist in Charge of Rice Investigations, Office of Cereal Investigations.

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THE RICE PRAIRIES.

THE PRINCIPAL RICE REGION of the United States lies on the Gulf coastal plain, where there are broad, level prairies extending approximately from Rayne, La., to Crosby, Tex. (Fig. 1.) These tracts of level land are broken here and there by sluggish streams. From them the irrigation water is obtained by the use of powerful pumps. As these streams are much lower than the prairies,

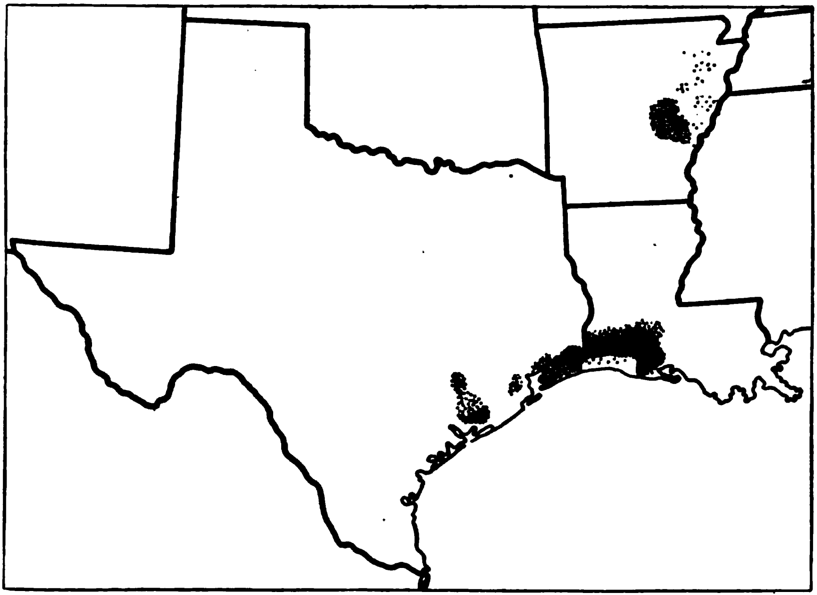

FIG. 1.—Outline map of Louisiana, Texas, and Arkansas, showing where prairie rice was grown in 1918 and indicating by dots the acreage devoted to the crop. Each dot represents 1,000 acres.

they also serve as the natural outlets for drainage. Deep wells also are used in this section to supply irrigation water for approximately 150,000 acres.

The rice area in Louisiana is located on the prairies in the southwestern part of the State, with the exception of a narrow strip of alluvial land, totaling 89,000 acres, along the Mississippi River. Since the early part of the nineteenth century rice has been produced in Louisiana, but the crop remained unimportant until it was demonstrated in Acadia Parish that it could be grown on the prairies.

The effect of the successful outcome of this agricultural venture increased the rice area in the State from 42,000 acres in 1879 to 84,377 acres in 1889. During the next 10 years there was such an increase in the number of irrigation plants and at the same time so great an enlargement of the canal systems that the acreage in rice in Louisiana reached 201,685 acres. By 1918 the prairie rice area in that State had increased to 491,893 acres. In Texas, where rice is grown only under prairie conditions, the area devoted to the crop increased from 178 acres in 1889 to 245,000 acres in 1918, 136,520 acres of which were located in southeastern Texas.

In acreage and production of rice the Louisiana prairies rank first and those of Texas second. Of the 1,112,770 acres of rice grown in the United States in 1918, the Louisiana and Texas prairies contained 736,893 acres.

There is a similar, though smaller, prairie district in eastern Arkansas (fig. 1), approximately 50 miles wide and 150 miles long, which in 1918 produced 7,310,000 bushels on 170,000 acres. The rice industry is of recent development there, for it was in 1905 that Arkansas, with 460 acres of rice, was first included among the rice-producing States.

CLIMATE.

On the Gulf coastal plain the summers are hot, with a relatively high humidity. The hottest months are June, July, and August. The monthly mean temperature for these months ranges from 79.9° to 82.8° F. The annual mean temperature ranges from 67.4° to 69.1° F. There are seldom any killing frosts between March 4 and November 15. During the winter months the weather is usually mild, though freezing temperatures sometimes occur. The precipitation is well distributed throughout the year and is approximately all in the form of rain, which greatly increases from the western to the eastern portions of this region. In southeastern Texas the average annual rainfall is 47.6 inches, but in the eastern part of the prairie district of southwestern Louisiana it is 54.6 inches. Destructive winds are not frequent, but the Gulf coast is exposed to West Indian hurricanes.

The Arkansas rice belt has an annual mean temperature of 61.5° F., with hot summer months. Killing frosts usually are three weeks later in spring and two weeks earlier in autumn than on the Gulf coast. The average annual rainfall of 52.05 inches is rather evenly distributed.

SOILS.

Rice is more productive on soils of medium to rather heavy texture than on lighter loams and sandy soils. The typical rice soil of Arkansas and southwestern Louisiana is the Crowley silt loam. This soil is a brown or ash-gray loam containing approximately 4 per cent of very fine sand, 69 per cent of silt, and 23 per cent of clay. It is noticeably rather compact in structure and has a tendency to puddle if plowed when wet. The subsoil, which lies at an average depth of 16 inches, is a mottled blue and yellow clay that is extremely impervious. The loss of irrigation water by seepage through this clay is so small that it is negligible.

In these districts there are other soils much lighter in texture on which rice is successfully grown. Beneath them the underlying soil is near the surface and is impervious; otherwise the soil would not be profitable for rice on account of the expense of maintaining the proper depth of irrigation water.

In Texas the soils are of a more tenacious character and therefore are more difficult to cultivate. They lie upon an impervious clay and on an average are no greater in depth than the Crowley silt loam. The Lake Charles clay is a typical rice soil of southeastern Texas. Its surface soil is dark gray, often mottled with yellowish brown, and 12 to 16 inches deep. The subsoil is similar in color and texture to a depth of 3 feet or more. There is considerable organic matter in the surface soil and subsoil, and yet this type of soil is very plastic and sticky when wet. This is characteristic of most of the rice soils of this State. Some of them crumble on drying, even when plowed in a very wet condition, while others can not be successfully cultivated unless plowed when the moisture conditions are just right. The latter is particularly true of the soils known as "hog-wallow land."

GENERAL REQUIREMENTS OF THE CROP.

Irrigation is an important feature in the culture of rice. Water must be applied continuously and at a uniform depth for many days. To meet these requirements the land which is selected for this crop should be level and underlain by a subsoil that is impervious to water. The expense of preparing a level tract for irrigation is less than for a rolling one, and the cost of maintenance is also less because there are fewer levees. The impervious stratum of soil should lie near the surface, for a deep soil requires more water and more time for its submergence than a shallow one.

The importance of good drainage can not be too strongly emphasized. Without it, the field can not be quickly drained for harvest. A delay in draining a field may cause a heavy loss in yield. It is also necessary in order to prevent water-logging, a condition which unquestionably affects the yield.

Clay soils when easily drained and not too deficient in organic matter seem well suited to the production of rice. Loamy and even sandy soils produce good crops of rice under ideal conditions of irrigation and drainage.

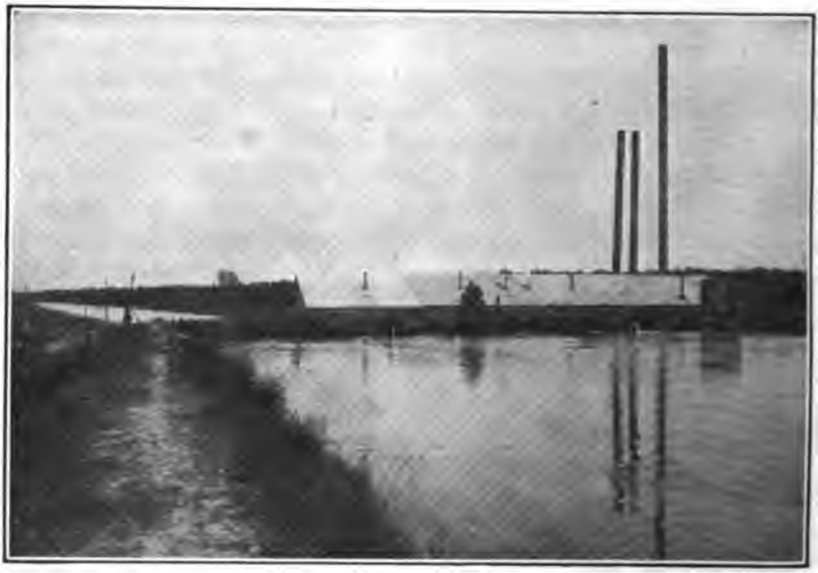

FIG. 2.—An irrigation canal and pumping plant, the second lift on the Neches Canal, Beaumont, Tex.

SOURCES OF IRRIGATION WATER.

The water needed for rice production on the prairies is obtained mostly from streams and wells. From the streams it is lifted by powerful pumps and distributed by canals, which are operated by private companies. These companies furnish the water on a rental basis. Before the recent war the rental ranged from $6 to $9 per acre per season. The water may be supplied in return for one-fifth of the crop, or it may be furnished for two bags of rice, averaging 180 pounds each, per acre. If land, seed, and water are furnished, a charge of one-half of the crop is made.

Although the major part of the rice acreage in Louisiana and Texas is irrigated from canals (fig. 2), the supply of water for at least 150,000 acres is obtained from deep wells. Most of the water that is used in irrigating rice in Arkansas is supplied from deep wells. When the deep well is the source of the water supply, the well and outfit are included in the farm equipment. The size and capacity of the pumping outfit depend upon the acreage to be irrigated and the height to which the water must be lifted. The minimum capacity of the pump should not be less than 7½ gallons, or 1 cubic foot of water per minute per acre.[1] Some of the less compact soils which are used for rice require at least 10 gallons per minute per acre.

METHOD OF APPLYING IRRIGATION WATER.

Level land with a gentle slope is well suited to the irrigation of rice. With such surface features a field can be irrigated economically and drained satisfactorily if the natural outlets are not too small or overtaxed. A rice field must be inclosed by strong levees in order to hold the water that may be put upon it. As it is also important to maintain a rather uniform depth of water in irrigating rice, the field must be divided into as many subfields, or "cuts," as are necessary to obtain this condition.

A competent civil engineer should be employed to locate the levees, especially those that separate the subfields. These levees (see fig. 10) should be permanent and constructed on contour lines at distances which will hold the water at an average depth of 5 inches. They should be at least 10 feet wide at the base and built up with sloping sides to a height that is just sufficient to prevent the water from overflowing into the subfields below. All kinds of farm machinery may easily pass over levees of this character without damaging them. This simplifies field operations, for such levees make possible the cultivation of an entire field as a unit instead of the separate cultivation of "cuts," which is necessary where high narrow levees are used. They also are of further service, as they can be seeded to rice and thereby increase the cultivated area. This prevents any waste of land and leaves no uncultivated strips in the field for the growth of weeds. Rice that is produced on these levees often is of a very good quality. The yield from these plants, however, may be lower than from those more favorably located, but the results obtained in the control of weeds alone will justify the practice.

Firm and compact levees are necessary to reduce seepage. They should be constructed and rebuilt during the winter. When constructed at this time they are more serviceable than when made just before water is applied. It is better to build new levees at least one-third higher than the required height. This will allow for settling and washing. It is cheaper than building up the levees with the shovel after the land has been submerged. The average cost of constructing field levees and laterals before the war was approximately $1.50 per acre. On land where only a few levees were needed the cost was as low as 20 cents per acre.

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[1] Haskell, C. G. Irrigation practice in rice growing. U. S. Dept. Agr., Farmers' Bul. 673, 12 p., 1 fig. 1915.

The water is admitted to subfields through openings in the levees. These openings should be controlled by wooden gates and not made with a shovel each time water is needed. The gates should consist of a floor and end pieces to hold a sliding shutter in a vertical position across the opening. The flow of water may be regulated by the shutter, which consists of narrow pieces of wood that may be increased in number or removed as the water is raised or lowered.

VARIETIES.

LONG-GRAIN RICE.

The long-grain rice of the United States is represented on a large commercial scale by the Honduras variety. Its seed is long and narrow, averaging in length two and one-half seeds and in width eight seeds to an inch. (Fig. 3.) It has a light-yellow awnless hull that is thinly covered with short white hairs. The awn, however, often is present when the variety is grown on very rich soil.

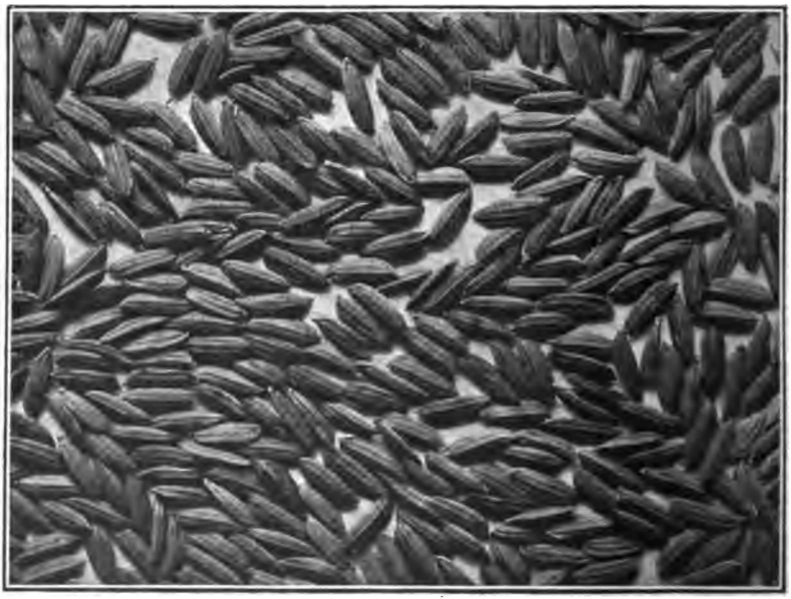

FIG. 3.—Seed rice of the Honduras variety. (Natural size.)

This variety is grown in all prairie sections, producing its largest yields on land that has not been cropped too heavily to rice, but in yield and quality it reaches its maximum on the alluvial river-bottom lands of the Mississippi in Louisiana. It has an erect growth, averaging 50 inches in height. Its stalks, which seldom exceed four per plant, are large and stiff and bear broad leaves. It shows no tendency to lodge except on very rich soil and withstands the usual winds and the rain accompanying the ordinary rainstorms. It is an early-maturing rice, requiring a growing season of approximately 128 days. In production it averages 1,996 pounds of paddy, or rough rice, per acre.

Honduras rice must be sown early enough to mature before becoming affected by the cooler nights and winds of September if maximum yields are to be obtained. For this reason this variety should be seeded not later than May 1. The entire plant matures rapidly, and any delay in harvesting may result in a low yield, because the branches of the head (botanically called a panicle) break off and drop shortly after maturity. The loss from this cause is greater than from the shattering of the grain. This variety is very susceptible to the fungous disease caused by Piricularia, and a delayed harvest increases the losses from this disease. To separate the grain from the straw requires careful thrashing. The stem and leaves are very brittle, and unless the thrasher is fed slowly it is not possible to get a good grade of rough rice.

SHORT-GRAIN RICE.

The short-grain varieties that are grown in this country are Japanese in origin and seem well adapted to prairie conditions. They are very hardy and produce large yields, but require a long growing season. On account of the first two qualities they are very popular with the farmers. They break less in milling than the long-grain varieties, and for this reason the millers prefer them. The general trade, however, shows a preference for the long-grain rice.

The Wataribune is a good example of the short-grain varieties. Its seed is short and broad, averaging in length four seeds and in width seven seeds to an inch. (Fig. 4.) The hull is light yellow in color and bears a light-yellow awn, at the base of which are tufts of short white hairs. Many of the awns drop before the crop is harvested, and those that remain are usually broken off in thrashing and in handling the sacks, so that this variety often goes to the mill with very few, if any, awns attached.

The Wataribune variety does not grow erect, but has a spreading habit and averages 39 inches in height. Its stalks, which seldom exceed nine per plant, are small and flexible and bear narrow leaves. On account of its spreading habit of growth and heavy heads, this variety has a tendency to lodge, which is very pronounced when grown on rich soil. On rather poor soil it may produce very good yields. It requires a long season, averaging 137 days, and produces on an average 2,600 pounds per acre. It should be harvested when the heads are yellow and well turned down, though the stem and leaves may still be quite green.

The irrigation water may be removed at least five days earlier from a field containing Wataribune than from one containing Honduras rice, because the stems of this variety do not mature rapidly, nor does the grain shatter readily.

The thrashing of this variety requires close attention, but the difficulties may be lessened by feeding the machine slowly. Short-grain rices hull more readily in thrashing than the long-grain varieties, but an adjustment of the concaves will reduce this loss.

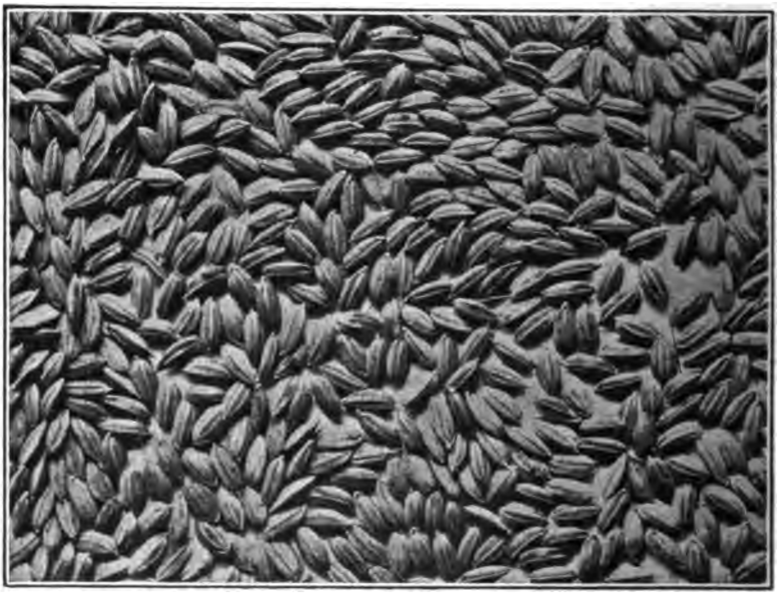

FIG. 4.—Seed rice of the Wataribune variety. (Natural size.)

MEDIUM-GRAIN RICE.

There is another variety of rice, known as Blue Rose, which is grown on a large acreage. Its grain is not as long as that of Honduras nor as short as that of Wataribune. The seed of this variety averages in length three and one-half seeds and in width seven and one-fifth seeds to an inch (fig. 5). Its light-yellow hull is thinly covered with short white hairs. These are numerous and conspicuous at the apex.

The Blue Rose variety has an erect growth and averages 44 inches in height. Its stalks are large and stiff, often numbering 13 per plant and bearing leaves which are broad, but not as wide as those of Honduras rice. On rich soil it shows a tendency to lodge, but in its resistance to wind it is very similar to the Honduras variety. It matures within 142 days and produces on an average about 2,500 pounds per acre. It should never be grown on very rich soil, and, unlike Wataribune, it makes very low yields on poor soil. The stem and leaves of this variety are still green when the grain is ripe enough to be harvested.

This rice should be handled at harvest in the same manner as the Wataribune variety. Any delay at this time may lessen production on account of its susceptibility to the fungous disease Piricularia. In thrashing there is some difficulty in preventing the large tough straw from clogging the cylinder and the leaves, which break easily, from going out with the grain.

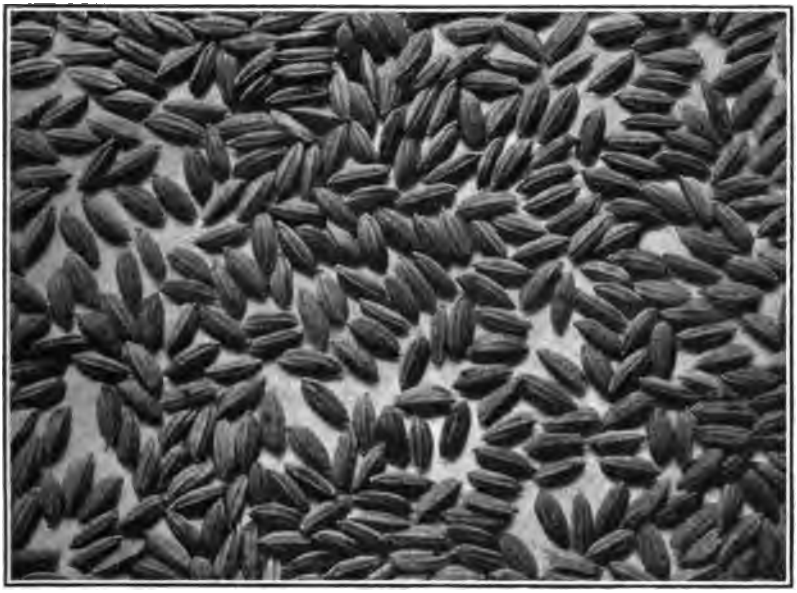

FIG. 5.—Seed rice of the Blue Rose variety. (Natural size.)

PREPARATION OF THE SEED BED.

In preparing a seed bed for rice the land should be plowed (fig. 6) in late autumn or winter to a depth of 5 to 7 inches.

It is not advisable, however, to break new land to this depth, especially if the soil is thin. Winter plowing will permit the free circulation of air in the soil if the land is well drained at this time. Under these conditions the frost will act upon the soil in such a way as to crumble it, and the winter rains will wash out any alkali that may have accumulated in the surface soil, producing a physical condition which permits easy preparation of the seed bed in the spring by disking and harrowing. It is, however, difficult and expensive to prepare land for seeding when it has been plowed in winter unless good drainage has been provided, for the lack of drainage during the winter may make it necessary to plow again in spring, thus adding to the cost of production.

On well-drained land the stubble and perennial weeds that are turned under by winter plowing decompose rapidly. This reduces the field operations in preparing the seed bed, which as a rule requires only one double disking and one harrowing (fig. 7) before seeding. A float (fig. 8) may be used to advantage to break the clods and level the field before disking. Before harrowing, the float may be used again to advantage. The number of times the float should be used will depend upon the condition and character of the soil. Land cropped to rice the previous year must have two double diskings after winter plowing. The first disking should be made in February or March, especially if there has been very little rain during the winter.

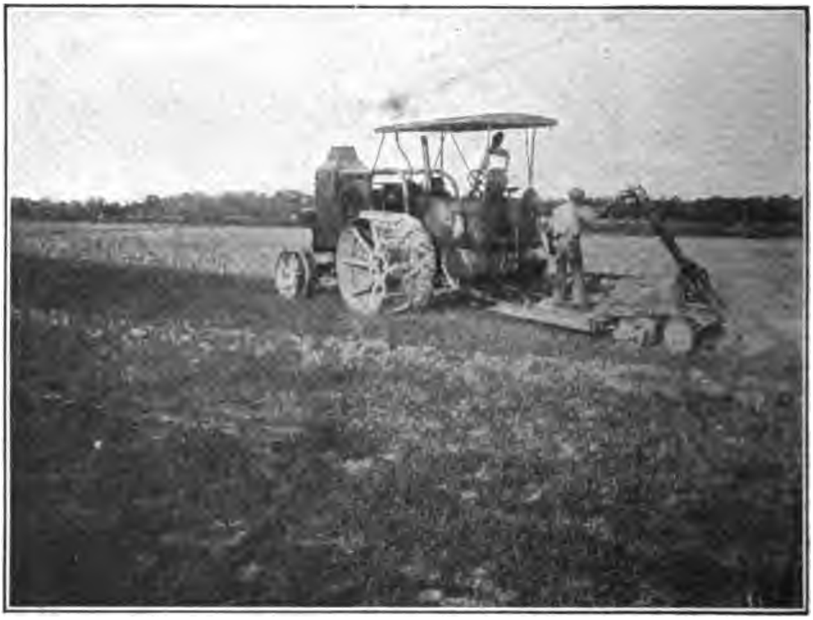

FIG. 6.—Plowing a rice field with a tractor, a common practice.

Spring-plowed land should be disked and harrowed immediately after plowing, because the soil dries out very rapidly under the action of the winds which usually prevail at this season, and if allowed to dry out a satisfactory seed bed can not be obtained. Under normal weather conditions, the heavy soils when spring plowed will require more disking and harrowing than if plowed in the winter. The use of the float also will be required several times. The lighter soils will need less work.

The surface soil of the seed bed should be loose and finely pulverized to a depth of at least 2 inches. A seed bed of this character retains moisture and increases the chances of good germination without irrigation. It also promotes such a vigorous growth of the young plants that submergence may not be required for 30 days.

PREPARATION OF THE SEED.

All seed rice should be graded and cleaned before it is sown. The fanning mill may be used for this purpose. Ungraded seed is likely to produce a poor stand, and the use of uncleaned seed is one way by which weeds may be increased or introduced into a field. Although rice without hulls may germinate under favorable conditions, the grade of seed rice containing it should be considered inferior for seeding purposes. It is more easily damaged by unfavorable weather following seeding than the perfect seed which has the husk or hull attached. The use of seed containing rice without hulls results always in a thin stand or a stand with many weak plants.

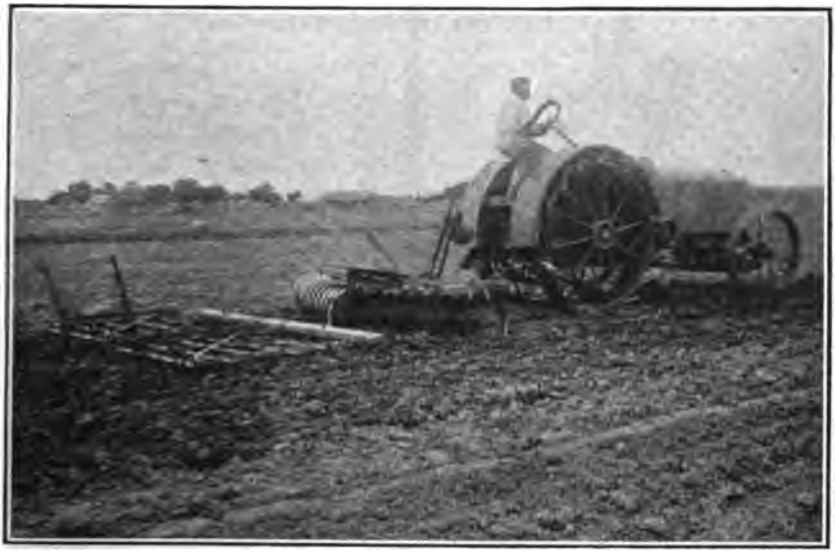

FIG. 7.—Preparing a seed bed for rice.

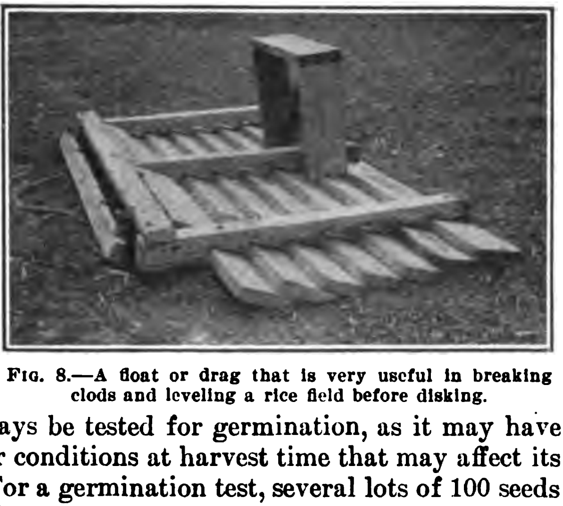

FIG. 8.—A float or drag that is very useful in breaking clods and leveling a rice field before disking.

Seed rice should always be tested for germination, as it may have been exposed to weather conditions at harvest time that may affect its germinating power. For a germination test, several lots of 100 seeds each should be taken from a sample of the seed to be sown. Each lot should be placed separately between blotting papers or canton flannel and kept moist at the temperature of a living room (70° F.) for at least a week. The number of seeds that have strong sprouts should then be counted. The seed that shows low vitality should not be sown, or, if used, the rate of seeding should be higher than that commonly recommended for the variety.

METHOD OF SEEDING.

Rice is usually sown with a 16-hole grain drill (fig. 9), although an end-gate broadcast seeder often is used. Of the two methods of seeding, drilling is preferred. It requires less seed and secures an even distribution at a more uniform depth, resulting in a better stand than usually is obtained by broadcasting. However, the latter has advantages. If the soil dries out rapidly when wet weather occurs after the seed has been broadcasted, the stand is likely to be better than if the seed had been drilled, because on account of the shallow seeding the young plants have less difficulty in emerging. Considering all the conditions under which the crop may be sown, seeding with a drill is recommended. The disk drill is ordinarily used, but the shoe drill may give just as good results.

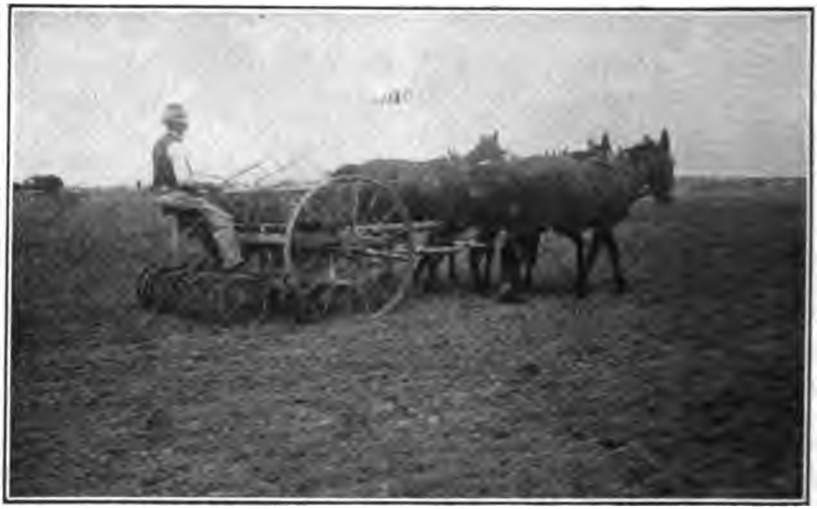

FIG. 9.—Drilling rice on a well-prepared seed bed.

TIME OF SEEDING.

On the prairies the greater part of the rice crop is sown from April 1 to May 15. Under normal weather conditions the Honduras variety when sown during the first week in May matures during the first week in September. The other commercial varieties that are grown in this region when sown at the same time mature on an average from 14 to 23 days later.

Rice sown during the first week in May germinates within 9 to 12 days, but when sown in early April it may not germinate for 14 to 20 days. Seeding at the earlier date is not safe, because of the low temperatures prevailing at this season. Cold rains also are quite frequent, and when they occur the crop is often so badly affected by the rotting of the seed that reseeding is necessary. If sown in the third week of May rice germinates within seven days. Seeding as late as June 1 may be an advantage on weedy land when the land is plowed in the winter and cultivated repeatedly in the spring until the crop is sown. Rice can not be sown with safety as late in Arkansas as on the Gulf coast because the growing season is much shorter. May 1 is approximately the best date for sowing rice on the prairies.

RATE OF SEEDING.

In experiments at the Crowley Rice Station in Louisiana the largest yields and best quality of the Honduras variety were obtained by drilling 80 pounds of seed to the acre. The medium-grain and short-grain varieties may be sown at the rate of 65 to 75 pounds per acre. Less seed may be used when the crop is sown in late May if the seed bed is well prepared, as better germination is obtained at this time than at an earlier date. The quantity of seed that should be sown depends upon the method of seeding, the variety of rice, the character of the seed bed, the fertility of the soil, and the vitality of the seed. If sown broadcast on wet land and on a poorly prepared seed bed all varieties should be sown in excess of the rate recommended. Seed of low vitality should not be sown. If it must be used, the rate of seeding should be greatly increased. Seeding at too low a rate is likely to permit excessive tillering, which will result in irregular ripening and reduced yields.

DEPTH OF SEEDING.

The depth to which seed should be sown depends upon the condition of the seed bed. It should not exceed 2 inches. In attempting to cover seed on cloddy land to the depth of 2 inches an uneven depth is obtained, and a poor stand results. A less depth is desirable on a seed bed with a good moisture content. Shallow seeding, however, is not safe if water is applied to obtain germination. Deep seeding on a seed bed in good tilth may result in poor germination if heavy rains follow immediately after the seeding. Such rains may cause the soil to run together and become so compact that the seedlings can not emerge, resulting in a total loss or a poor stand. The damage may not be so great if the rains occur just before germination and if the soil does not dry out too rapidly.

FERTILIZERS.

Among the rice farmers in the section covered by this bulletin who use fertilizers, it is not the practice to apply fertilizers containing the three important elements of plant food—nitrogen, phosphorus, and potash. The fertilizers that are commonly used contain from 10 to 12 per cent of phosphoric acid and 2 to 4 per cent of potash. They are applied at the time of seeding at acre rates varying from 150 to 200 pounds of acid phosphate and from 30 to 50 pounds of muriate or sulphate of potash. The rice soils of the prairies are, as a rule, deficient in phosphorus, but in most of them there is enough potash. When absent, these plant foods can be restored to the soil in the form of commercial fertilizers. Even when they are present they are not always available, though a good supply of decaying vegetable matter in the soil tends to make them so. It is important, therefore, that the soil should be supplied with humus in order to get the full use of the plant food that may be stored in it.

If conditions are made favorable for nitrification, or the formation of nitrates, considerable nitrogen may also be furnished by this vegetable matter. Plowed-under stubble on well-drained land will greatly increase the amount of available nitrogen and may supply what is needed. A large part of the nitrogen and potash consumed by the rice plant is stored in the straw and is saved if the straw is plowed under. The burning of straw piles and stubble, therefore, is wasteful, so far as nitrogen is concerned. The potash is not completely lost, however, if the ashes of the burned straw are returned to the soil.

Most cultivated plants obtain their supply of nitrogen in the form of nitrates. These are made from vegetable matter through various processes of decay and oxidation. This requires free circulation of air in the soil. In the absence of the free air, these processes cease altogether or proceed at a very slow rate. During the greater part of the growing season rice is grown on submerged soil and under conditions which are unfavorable for the formation of nitrates. It is generally believed, however, that whenever sufficient organic matter is present, enough ammonia is formed to supply the nitrogen needs of the rice plant. In other words, rice may obtain its nitrogen in the form of ammonia. Ammonium sulphate and organic nitrogenous fertilizers are good sources of nitrogen for rice. The yield of rice has been greatly increased by the application of ammonium sulphate when supplied at the rate of 70 pounds per acre.

Nitrogenous fertilizers should be used with great care, for they produce a heavy growth of stem and leaves. Too heavy an application of such fertilizers is likely to result in lodging. To maintain the supply of nitrogen a leguminous crop should be grown in rotation with rice.

Lime may be applied with benefit to acid soils, but since rice can endure greater acidity than other plants the use of it may not always be an advantage. Excessive liming may reduce yields and affect the availability of phosphoric acid. For these reasons lime should be used in small quantities until the effect of it upon the soil and crop is determined. It may be used in the form of ground limestone, marl, or quicklime, but, of course, quicklime should be slaked before it is applied. Lime should be spread broadcast and harrowed in.

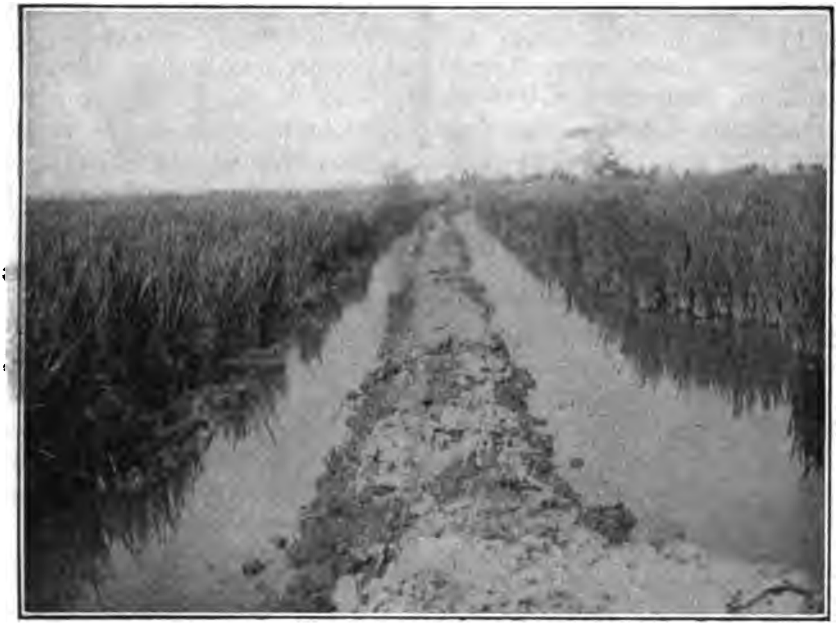

FIG. 10.—A field of rice. The land is covered with 5 inches of water. The levee in the center of the picture should have been made broader and lower and seeded to rice.

TIME TO APPLY IRRIGATION WATER.

The irrigation water usually is first applied when the young plants have reached a height of 6 to 8 inches. The subfields at this time are submerged to a depth of 1 to 2 inches. This depth of water is increased slowly until the maximum depth of 5 inches is obtained (fig. 10). By this time the plants should have reached a height of at least 2 feet. Throughout the growing season the maximum depth is maintained, fresh water being supplied when needed to equal the losses from seepage, evaporation, and transpiration. Irrigation is seldom used to germinate the seed except when the crop is sown at an early date.

When irrigation is required for germination, great care must be used in applying the water, for if water is left on the land too long at this season of the year it is likely to cause the seed to rot. Before the plants come up, water should not be allowed to remain on the land longer than 48 hours after each irrigation. Under these conditions, the soil should never be allowed to bake before the plants have come up.

The amount of water required to make a good crop of rice will depend largely upon how well the outside levees have been constructed and what quantity of water is allowed to flow through the field. To conserve water, the levees should be made as seepage proof as possible. Poorly constructed outside levees are responsible for the loss of much water. The loss is further increased by allowing too much water to flow through the fields in an effort to keep the water fresh. Under general field conditions 28 acre-inches of irrigation water are required to produce a good crop of rice. This is in addition to the normal rainfall of 20 inches in the irrigation period.

DRAINAGE.

The irrigation water should be removed promptly from the rice field when the crop is ready to be harvested. To do this effectively, ample provision should be made for draining the field at harvest time. This will require a number of ditches of sufficient depth and width to drain the soil thoroughly as well as to remove the surface water. They must be kept free from all kinds of obstructions, especially weeds, which grow luxuriantly in them, or their efficiency will soon become greatly impaired.

The number and location of these ditches will depend upon the surface features of the land under cultivation. The surplus water should be carried away quickly. This can be done by connecting the field outlets with watercourses or artificial channels of sufficient capacity. The latter is an engineering problem requiring community cooperation and is being solved in many localities by the creation of drainage districts.

On fields that drain slowly there is always a delay in harvesting the crop, which invariably results in the loss of grain from shattering. This lack of drainage or poor drainage facilities will add also to the cost of production in the additional time and labor required to cut and move the crop from a boggy field. During the winter, all drainage outlets should be kept open, so that surplus water can not remain on the land. Such attention will prevent water-logging and serve to aerate the soil. The importance of having control of these conditions is strongly emphasized, for without this control maximum yields can not be obtained.

HARVESTING THE CROP.

Rice is harvested with a twine binder (fig. 11), with the exception of a comparatively small acreage along the Mississippi River, where the crop is cut with a hand hook. Rice should not be left standing until fully ripe, but should be cut promptly when the kernels in the lower part of the heads are not entirely hardened. This stage of maturity is indicated by the position of the heads, which are well turned down. If cut earlier the quality of the rice will be greatly affected by a large percentage of imperfectly formed kernels. If cut later there will be a loss of grain from shattering.

SHOCKING.

The harvested grain should be shocked in such a manner as to protect it from sun and rain. Too long an exposure to the sun is likely to crack the grain, and too much dampness will affect the proper hardening of it. Shocking should be promptly and carefully done. In a large measure the value of the crop depends upon the thoroughness of this work. Rice that has been carelessly shocked can not produce the maximum yield of head rice when milled. It is this grade of milled rice that commands the highest price, and the miller makes his highest bid on the rough rice which in his opinion will produce the largest proportion of this grade.

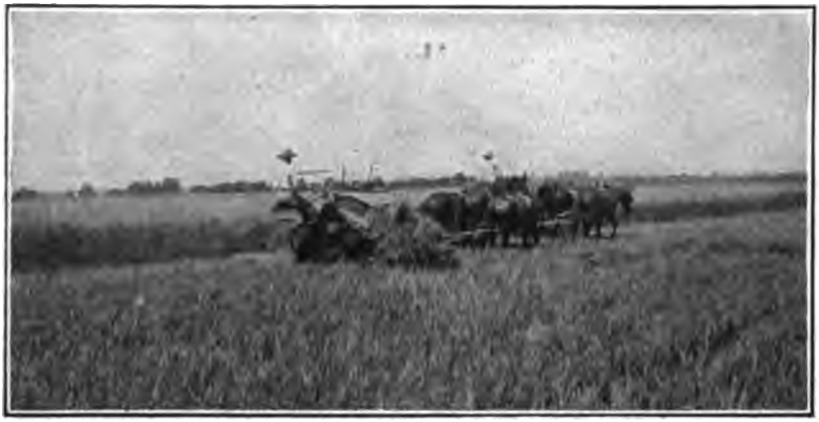

FIG. 11.—Cutting rice with a twine binder. Before harvest the irrigation water is drained from the field.

The shocks (fig. 12) should be strongly built to withstand the wind and well capped. The first two bundles of a shock should have the butts firmly set into the stubble and sufficiently apart to be well braced when the heads are brought together. Place around these 8 to 10 bundles, so as to form a round shock, making provision at the same time for free circulation of the air. A large bundle should be selected to serve as a cap. Slip its band down to the heads and put it in an upright position, with the heads down in contact with the heads of the bundles forming the shock. When it is in this position, open the bundle from the center by bending the straw at the band. Pull down the straw and spread it evenly to make a covering for the heads of the cap bundle and the underlying bundles. When the straw is wet or not entirely ripe, it is probably safer to make a smaller shock.

THRASHING.

Rice should not be thrashed (fig. 13) until the kernel is hard and the straw thoroughly dry. This requires at least two weeks in the shock when the weather is dry. If the weather is rainy this period may be considerably prolonged. The damage to grain in a well-constructed shock exposed to heavy rains is negligible compared to the loss that may occur when thrashing is done too soon. The grain should not be thrashed too early in the day, even though it has been thoroughly cured in the shock. If thrashing is attempted while the straw is damp with dew there is likely to be poor separation and, of course, a loss of grain. There is danger, also, of further loss by heating if the grain is sacked and stored while damp. When thrashing is done under contract or where more than one variety is grown on a farm, special attention should be given to the cleaning of the separator. This is necessary to keep the varieties as pure as possible and to prevent the introduction of weeds from neighboring farms. Rough rice is greatly improved in grade by careful thrashing, and too much attention can not be given to the adjustment of the concaves in order to prevent hulling and cracking.

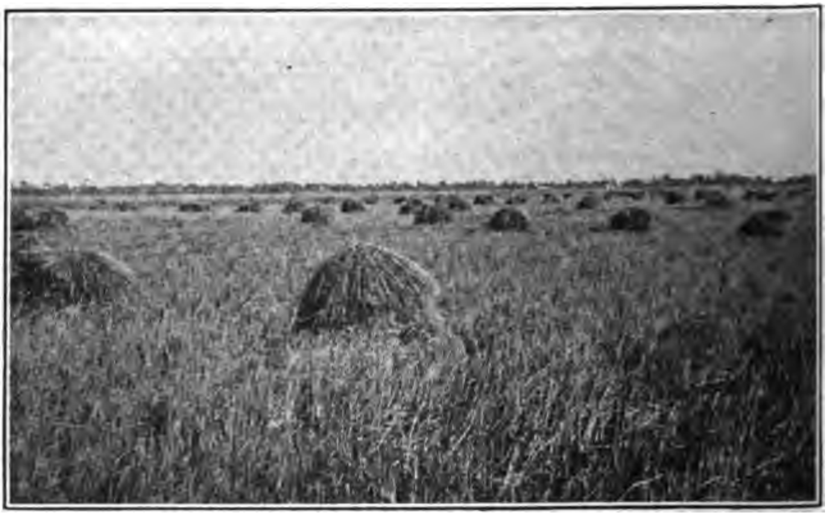

FIG. 12.—A field of shocked rice in Louisiana. These shocks have been strongly built and well capped, to protect the grain from rain and sun.

WEEDS.

The conditions under which rice is grown favor the rapid and rank growth of other plants that thrive in water and wet soil. These plants may become troublesome weeds if not eradicated when they first appear in the field. If weeds are allowed to grow they may reproduce so rapidly that a large part of the field may soon be occupied by them and thus cause heavy loss by reducing the rice yield. The loss is further increased by the presence of their seeds in the rough rice, which greatly affects the value of the crop. A weedy crop never has a high market value.

On account of their general hardiness and the large number of seeds which many of them are capable of producing, weeds are not easily controlled. Since the control and eradication of weeds increase the cost of production, it is very important that every method be used to prevent them from getting into the field. The danger of weed introduction may be greatly reduced by using only seed rice that has been thoroughly cleaned. To prevent the distribution of weeds by irrigation water and wind, all ditches and levees should be kept clean. If weeds are allowed to grow in these places they will soon be scattered to all parts of the field. The community thrashing outfit often is responsible for the distribution of weeds and should always be thoroughly cleaned before using.

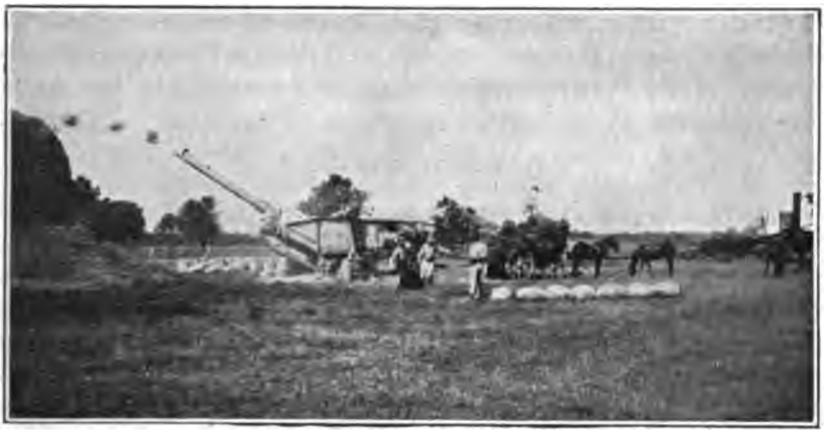

FIG. 18.—Thrashing rice in Louisiana.

RED RICE.

The worst weed of the rice fields of the United States is red rice. It is well distributed throughout the rice-producing countries of the world. The seed coat of the kernel of this rice is red, a characteristic which may serve to distinguish it from the white rices. It is introduced only through the use of seed containing red rice. Wherever this happens it soon takes possession of the field unless active measures are taken to eradicate it. In discussing seed rice from the standpoint of red rice only, the importance of pure seed can not be overestimated. After heading, red rice can be readily distinguished from our commercial varieties by its loose, open, slightly drooping head with comparatively few grains on the branches.

A slight infestation of a small acreage may be easily controlled during the first year by pulling up the individual plants and removing them from the field. If this is not done the quantity of red rice the second year will be greatly increased, for the seed of this rice shatters very badly. Of course, some of it will be harvested and thrashed with the main crop, but the quantity will be proportionately small, though large enough to affect the grade. The presence of red rice always lowers the value of the crop.

It is a common practice to pasture every second year fields that are badly infested with this weed, instead of cropping them successively to rice. In some localities such fields are summer fallowed. These methods serve to control red rice in a limited way, but can not be relied upon to eradicate it.

BARNYARD GRASS.

Barnyard grass (also known as barnyard millet) is a common rice-field weed. It has been known and kept under control in South Carolina by hand cultivation for more than a century. In the prairie-rice districts this weed has caused no heavy losses, but it is spreading so rapidly in some localities that an effort should be made to control and eradicate it. It is a coarse, erect or spreading annual, varying in height from 12 to 48 inches. It is widely distributed in all cultivated regions and grows luxuriantly in fields that are irrigated. It is not safe to allow a single plant to go to seed, as it produces a large number of seeds under the conditions that prevail in a rice field. This weed probably has been more widely distributed through the use of the seed rice containing its seed than by any other means. If it is allowed to grow upon the banks of irrigation ditches the water from them will carry its seeds over entire fields.

Seed rice containing the seed of this grass should not be used. As soon as this weed appears in a field it should be destroyed; at any rate before it produces seed. On account of their large root systems it is not practicable to pull up the plants. They should be cut below the surface of the ground to prevent new growth. Plants which have been cut at the surface have been known to grow and produce seed several times during a season. As soon as they have been cut the plants should be removed from the field, for if allowed to remain in moist or wet places, they will continue to grow.

This weed may be controlled by summer fallowing if the soil is so tilled as to make favorable conditions for the germination of the seeds that are in it. Shortly after germination, before the plants have had time to flower, they should be destroyed by shallow cultivation. Frequent shallow cultivations followed by irrigation to insure good germination of the remaining seed should result in complete eradication.

OTHER WEEDS.

No list of rice-field weeds would be complete that did not contain the large indigo, curly indigo, bull-grass, alligator head, Mexican weed, and many species of sedges. Of these the Mexican weed is the most difficult to control and eradicate. The crop losses due to these weeds may be greatly reduced by using a cultivated crop in rotation with rice where such a crop can be profitably grown.

DISEASES.

In this country the rice plant is subject to attack by several diseases, only a few of which are of economic importance. One of these is apparently of nonparasitic origin, although several organisms have been found associated with it.

Blast, blight, and rotten-neck are common names for a fungous disease caused by *Piricularia oryzae.* This fungus attacks the swollen base of the leaf sheath and the base of the upper leaf blade, and also is especially severe on the stem at the point where the head is attached, often called the neck. The general effects of the disease are seen in the paling and drying of the leaf and stem and in the poor condition of the head. When the neck is affected, the kernels are usually poorly filled. If the attack occurs at this point after the kernels have developed, the stem usually breaks, resulting in the loss of the head and, of course, in reduced yields. The disease is occasionally very destructive to the young plants, causing the leaves to dry and shrivel. No preventive and remedial measures can be recommended until more is known about the life history of the fungus. As its greatest damage is done late in the season, the use of early-maturing varieties may lessen the losses. Varieties may be developed that will satisfactorily resist the disease.

The green smut (*Ustilaginoidea virens*) and the black smut (*Tilletia horrida*) occur so seldom in the United States that at present they are not of economic importance. Under certain favorable conditions they might become serious diseases.

The general effect of the disease commonly referred to as "straighthead" is seen in the erect and green heads, which seldom set any seed. All efforts to trace its origin to parasitic fungi or bacteria have failed. There is evidence that straight-head is caused by unbalanced soil conditions, connected in some way with soil preparation and irrigation. The plant, and particularly the head, remains green much longer than normal. No specific recommendation for its control can be made.

INSECTS.[1]

Among injurious insects may be mentioned several species which attack the stem and roots and developing kernel of the rice plant.

The developing rice kernel is often punctured by sucking insects, the most common one being the stinkbug (*Oebalus pugnax*), which also feeds on many grasses. When the kernel is punctured while in the very early milk stage it shrivels so badly that it becomes valueless. If punctured later its milling quality may be greatly affected, and if it should escape breaking in the milling processes its value as a finished product is lowered considerably because of the discoloration made by the growth of saprophytic fungi and bacteria within the puncture. This insect is not a serious pest until the individuals become numerous. As this does not occur until late in the season, late-maturing rices are more exposed to attack.

The stem of the rice plant is sometimes attacked by the larva of a moth (*Chilo plejadellus*). After boring into the stem the larva feeds upon its interior surface. This weakens the straw, and when the head emerges, after the attack, it loses its green color, becomes white, does not flower, and consequently does not set seed. The damage done by this insect is never great, and the infestation is usually local even in a small field of rice. As a general rule the insect attacks only plants where the growth is thick. Rices with large stems are more subject to injury than those with small ones.

The rice water-weevil[2] (*Lissorhoptrus simplex*), which in its larval stage is known by rice farmers as the "rice root-maggot," is the most injurious insect enemy of growing rice. It is known to damage the rice crop annually, but the extent to which it alone is responsible for low yields is not easily estimated. The loss, however, is large enough to make it worth while to use means for its control.

As soon as the irrigation water is applied to the rice fields, the adult weevil, which is approximately one-eighth of an inch long, appears and begins to feed on the leaves of the young rice plants. The injury done at this time is slight compared with the work of the insect in its larval stage upon the roots of the plant. The larvæ feed entirely upon the roots. It is the severe pruning that they give the roots which affects production. The plant is seldom killed, but its growth may be seriously stunted by the loss of many of its roots. The destroyed roots are gradually replaced by new ones. If the attack is not prolonged the injured plant revives and makes a very good growth, though it usually is late in heading. The bad effects of the larval attacks are seen in the unequal growth of the plants in the field. This causes the crop to ripen unevenly and delays harvest, which increases the risk of loss by shattering.

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[1] For more detailed information in regard to rice insects, see Webb, J. L., How insects affect the rice plant. U. S. Dept. Agr. Farmers' Bulletin. In press.

[2] Tucker, E. S. The rice water-weevil and methods for its control. U. S. Dept. Agr., Bur. Ent. Circ. 152, 20 p., 2 fig. 1912.

The most practical method for controlling this insect is to drain the fields within three weeks after the application of the irrigation water, while the larvæ are still young and before they have weakened the plants too much. Drainage at this time, if the fields are kept dry for at least two weeks, will destroy the larvæ in large numbers. A longer period of dry growth, especially if no rains occur, may injure the rice, and a shorter period is not likely to have any effect on the insect.

RICE PRODUCTS.

Rice leaves the thrasher with the hull or husk attached. It is called rough rice and in this condition is sold to the miller. In the mills it is prepared for the market. After the removal of the hull and seed coats, or skin, the kernels are polished. This process improves the commercial value of the rice but decreases its food value.

After the rough rice has been cleaned, to remove all kinds of trash, it is conveyed to the milling stones, between which the hulls are removed. From these stones it passes over horizontal screens, where the hulls and the whole and broken kernels are mechanically separated. The unbroken kernels are now conveyed to a set of machines known as hullers, in which the outer skin and much of the gluten layer of the grain, together with the germ, are removed by friction. After leaving the hullers the rice is screened in order to free it from the bran. It is again subjected to another scouring in a second set of hullers or in a pearling cone. It is now ready to be polished—a process which gives the kernels the pearly luster that is demanded by the general trade. In the polishing process more of the gluten layer and many layers of starch cells are rubbed off. This product is called rice polish. After the polishing the rice is screened. If it is to be coated with glucose and talc, as is generally done, it is conveyed to a revolving cylinder where the coating material is applied. The different grades of cleaned or milled rice are afterwards separated.

The unbroken kernels of milled or cleaned rice are known as head rice. This kind of rice always commands the highest price and is sold under several grades, which vary in the different markets but are separated largely upon the brilliancy of the polish and the color and size of the kernels. The broken kernels may be sold as ordinary or broken rice, screenings, or brewers' rice. The last grade is composed of very fine particles of the kernels.

The principal feeds that are obtained from rice are bran, meal, and polish. The bran is composed of the seed coat and the embryo with varying quantities of hulls. Bran that contains no hulls, or comparatively none, is called meal. It is the most nutritious of the rice feeds and when fresh is very palatable to domestic animals. On account of its high percentage of fat it often becomes rancid if kept too long. In the polish the percentage of fat and protein is much lower than in meal, while the percentage of starch is much higher. Polish is used for feeding cattle and pigs.

SUMMARY.

Prairie rice constituted approximately 75 per cent of the 40,424,000 bushels of rice produced in the United States in 1918.

Clay soils that are not too deficient in organic matter are adapted to rice culture when they lie in level tracts and can be cheaply drained.

Rice requires an abundant and always available supply of fresh water.

Poor drainage or the lack of drainage results in reduced yields and in a poor grade of rice.

The field levees should be low, broad, and permanent and constructed on contour lines at distances which will hold the water at an average depth of 5 inches. They should be seeded to rice, which will prevent any waste of land and leave no uncultivated strips in the field for the growth of weeds.

The surface soil of the seed bed should be loose and finely pulverized to a depth of at least 2 inches.

May 1 is approximately the best date for seeding rice on the prairies.

The harvested rice should be shocked promptly, to protect it from the sun as well as the rain.

The shocks should be strongly built to withstand the wind and should be well capped.

Rice should not be thrashed until it has been in the shock for at least two weeks.

The danger of introducing weeds may be greatly reduced by using only seed rice that has been thoroughly cleaned and produced on fields that are not infested.

WASHINGTON : GOVERNMENT PRINTING OFFICE : [illegible]

UNITED STATES DEPARTMENT OF AGRICULTURE

Farmers' Bulletin 1093

A1.9:1093

United States Department of Agriculture

Influence of the Tractor on Use of Horses

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THE FIRST QUESTIONS that the prospective tractor owner asks are:

For what operations can I use the tractor?

In what operations will it displace horses in whole or in part?

How many horses will it displace on my farm?

This bulletin is designed to help the farmer answer these questions for himself. It is based on the personal experience of 191 tractor owners in seven Corn-Belt States. It shows that on these farms the number of horses kept was two or three per farm less after the purchase of tractors, that the average size of the farms was 22 acres more, and that the horses left on the farms did 75 per cent of the tractive work, while the tractors did 25 per cent. All the reports emphasize the fact that the great advantage of the tractor lies in its ability to save time at critical seasons when time is precious and the success or failure of an entire crop hangs on the speed with which it is handled.

Office of the Secretary
Contribution from the Office of Farm Management
H. C. TAYLOR, Chief
Washington, D. C. May, 1920

INFLUENCE OF THE TRACTOR ON USE OF HORSES.

(CORN BELT—191 FARMS.)

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GENERAL CONDITIONS.

TRACTOR INVESTIGATIONS, with special reference to the influence of the tractor on horse labor, were made in the summer and fall of 1918 on 191 Corn-Belt farms. The operators of these farms, all tractor owners, were visited by a representative of the United States Department of Agriculture, and detailed information on all farm operations was gathered. The inquiry covered a full year's work, so that the part played by the tractor might be noted in all its relations. The aim of this bulletin is to present the more important facts brought out by the reports of these farmers.

The investigation was carried on in Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, and Nebraska. In each of these States localities were visited in which a large number of tractors were in operation. The information obtained and here presented, while perhaps strictly and fully applicable only to the farms visited, may be taken as a general guide as to the results which might be obtained in using a tractor on any Corn-Belt farm of like type and organization. Of course the statements here made and conclusions drawn are not advanced as being final, but simply as additions to the available information regarding farm tractors.

NOTE.—Acknowledgment is due to Mr. H. R. Tolley, of the Office of Farm Management, for valuable assistance in the preparation of this bulletin.

In figure 1 the seven Corn-Belt States are shown. The black area in each State shows the section where the information was obtained. The same number of reports was obtained from each State.

To obtain results which would give as near a representative average as possible, an effort was made to get reports covering tractor operations under as many different conditions as possible, and hence the conditions represented range from adverse to ideal. The farms visited ranged from flat to hilly. The soils varied from the heaviest gumbo through all the various loams to light, drifting, sandy soils. Some of the gumbo soils now under cultivation on these farms were formerly unproductive, owing to the inability of horses to plow these soils. With the introduction of the tractor, this land has come under cultivation and is now yielding big returns. It was found that tractors were operated successfully in what would be termed unfavorable as well as favorable seasons, which would tend to show their general adaptability.

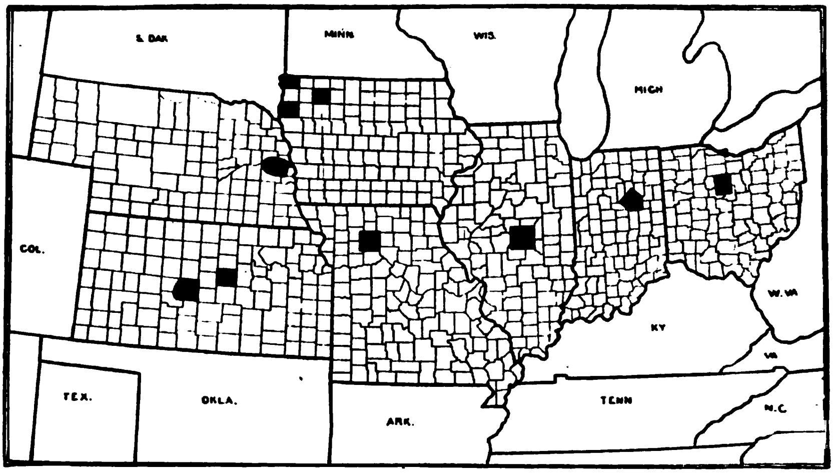

FIG. 1.—Corn-Belt States, showing areas where data were obtained.

While the section covered is roughly called the Corn Belt, farm practices are not uniform throughout the region. In most parts of the eastern Corn-Belt States commercial fertilizers and lime are used, these being applied by horse-pulled distributors. In preparing the land for crops all the ground may be plowed, or the small grain may be seeded on the previous year's corn ground by disking or harrowing, without plowing. The latter practice reduces work for horses or tractor in the busy season. Whether most of the plowing is done in the fall or only a small part, and the rest in the spring, depends largely on location. Where fall and spring plowing are done in about equal amounts on individual farms, the tractor is used more in the fall than in the spring, and horses vice versa. It was found that when all the reports obtained were grouped together only five more operators plowed in the fall than in the spring, but the number of acres plowed in the fall averaged 23.7 more per farm. The number of men using horses as an auxiliary source of power was practically the same in each case. The number of acres plowed by horses averaged 18.6 more per farm for the fall than for the spring.

Many farms have woodlands, and as these are cleared the tractor is used for sawing the wood for market, thus increasing the days of belt operation. The scarcity of labor in 1918 hampered the gathering of crops, and in the States on the eastern edge of the Corn Belt the tractor was used to a considerable extent in the hay field, to the exclusion of horses.

As corn is the principal crop in this region, the effect of the tractor on horse labor will be more noticeable in the case of this crop than that of any other crop grown, the average acreage of corn per farm of those visited being 83.5 acres, which is 32 per cent of the tillable area of these farms. The remaining crops grown on these farms, in order of crop acreage, are: Wheat, hay, oats, barley, and rye.

In this bulletin only the physical relationship of tractor power to horse power has been considered, and no attempt is made to compare the relative costs of doing work by these sources of power. The number of horses displaced on these farms is also shown, but no inference has been drawn as to whether the work is being done more cheaply as a result of the change.

SUMMARY OF RESULTS.

Briefly summarized, these are the principal facts brought out or emphasized by this study:

1. The number of horses disposed of on 141 farms averaging 346½ acres, on which tractors had been used for a year or over, was 2½ per farm.
2. The average number of tillable acres per horse increased from 26½ to 38½ after the purchase of the tractor.
3. Nine operators out of 191 displaced horses entirely on plowing, disking, and harrowing.
4. Only 16 operators allowed their horses to stand idle while the tractor was in use.
5. The number of horses displaced by the tractors on these farms was governed by the number it was necessary to retain for corn cultivation and other work current at the same time, which the tractor could not do.
6. The horses remaining on these farms are doing about 75 per cent of the tractive work and tractors the remainder.

7. The tractor was used for an average of 29 ten-hour days per year on the home farm. No record of the amount of custom work done was obtained.

8. A three-plow tractor on these farms does the work of 8½ horses in plowing, disking, harrowing, and harvesting.

9. After purchasing the tractor, the average size of the farms was increased by 22 acres, or 6¾ per cent.

10. The principal advantage of a tractor is its ability to do heavy work in a shorter time than it can be done with horses.

SIZE OF FARM.

The farms visited in this study varied considerably in size, the smallest being of 80 acres and the largest of 1,640 acres. Only one tractor was used on each of these two farms, while some of those between these limits operated two or even three machines. As a rule, the smaller farms were found in the eastern section of the Corn Belt.

The average size of all the farms visited was 323.8 acres, or, in round numbers, a half section. No definite statement can be made from the figures obtained as to the smallest farm on which a tractor is profitable. This will have to be left entirely to the individual and his particular needs and desires. While it would appear from available reports that a tractor will not prove a profitable investment on a farm of 80 acres, in some cases the end to be accomplished may justify the expense on such a farm.

The 141 farms of various sizes upon which tractors had been in operation for a year or more were arranged into seven groups according to acreage. The size of each group and the number of farms are given in Table I, and it will be noted that the greater number of farms fall in the groups ranging from 141 to 220 acres and from 221 to 300.

TABLE I.—*Number and size of farms.*

Size of farm.	Number.	Size of farm.	Number.
Under 141 acres	10	381 to 540 acres	18
141 to 220 acres	36	541 to 700 acres	16
221 to 300 acres	35	701 acres and over	10
301 to 380 acres	16	Total	141

The size of the farm, for the present at least, has a close relationship to age of the tractor, for it is found that on the farms of 540 acres and under the tractors in service have been used an average of about two years, while on the farms of 541 acres and over the average age is three and three-quarters years. This is due to the fact that the large tractors, which were the first to be manufactured, as a rule, were purchased by owners of large farms, while the small farm, which as a general thing could not economically use a large tractor, waited until the advent of the small machine, which is of comparatively recent manufacture. The size of the tractor and farm is shown in Table II (see p. 8). It will be seen that but for the few exceptional cases where small tractors were on large farms and vice versa, the difference in age would be still more marked.

An important trend is indicated by the effect of the tractor on the size of the farm, which was often increased after the introduction of the tractor.[1]

Of a total of 55 farmers who reported a change in acreage, 46, or 83½ per cent, reported an increase, averaging approximately 110 acres each. The remaining nine farmers, or 16½ per cent, reported a decrease, averaging 154 acres. These men moved to smaller farms and were not able to rent more land. It is not always possible to increase the size of farm at will, since additional land is not always available in the immediate vicinity.

Of the number using tractors who reported their acreage unchanged, several said that they would have increased the size of their farm, but because of lack of help found it impossible to do so. In a large number of cases where the tractor was purchased for use in 1918, the purchase was made so that the farm work could be done; otherwise some of the land would have been idle. The labor saved in these cases is reported as amounting to from one to three men, depending on the size of the farm. Another saving by the tractor, then, is that of hired help, since it enables one man to handle an increased acreage.

SIZE OF TRACTOR.

Five large tractors were found ranging in size from 8- to 12-plow and in age from 8 to 12 years. All other tractors ranged in size from 2- to 6-plow. Just as the acreage of the farms from which reports were obtained increases according to the location from east to west, so also does the size of tractors increase according to location from east to west. Most of the tractors found ranged in size from 2- to 5-plow.

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[1] See also Farmers' Bulletin 963, p. 7.

Table II.—*Size of farms visited and size of tractors on each.*

Number of bottoms.	Number of acres, inclusive.							Total number of tractors.
	Under 141.	141 to 220.	221 to 300.	301 to 380.	381 to 540.	541 to 700.	701 and over.	
	Number of tractors.							
2	14	30	17	1	7	......	......	69
3	6	16	26	15	12	10	5	90
4	1	1	3	2	2	3	3	15
5 and over	......	1	1	2	1	8	4	17
Total	21	48	47	20	22	21	12	191

It will be seen (Table II) that the 3-plow machines considerably outnumber any of the others. This size of tractor seems to be the most popular among farmers in general and is the same size as was recommended by farmers in Illinois, as shown by an earlier investigation.[1]

When it was realized that the large tractor was not suitable for the ordinary Corn-Belt farm, the tendency was toward the small tractor pulling two plows, the result being that many farmers went to the other extreme and bought machines too small for their needs. The 5-plow tractors and larger average 5½ years old, the 4-plow 2⅜ years old, the 2-plow 2 years old, and the 3-plow slightly less than 2 years old. This indicates that the latest size to be tried out extensively is the 3-plow machine.

Judging by the figures in Table II, there does not seem to be as yet a fixed opinion in the minds of these men as to the number of acres on which machines of given sizes are most profitably operated. It seems that the operators who are using 2-plow machines on farms of 301 to 540 acres, 4-plow machines on farms of 220 acres or under, and 5-plow and over on farms of 300 acres or under, would have done well to have investigated the experiences of other men before buying their tractors.

The average size of the farms upon which the 2-bottom tractor was used is 224 acres; 3-bottom, 334 acres; 4-bottom, 493 acres; and 5-bottom and over, 623 acres.

AGE OF TRACTOR.

As has already been said, the small tractor has been developed since the large machine, and it is now the tendency for the smaller tractors to outnumber the large machines, which, however, are still manufactured to a considerable extent. The tractors in question, when arranged according to age, show more machines of from one to three years old than of all other ages combined. When the machines one year old or over are arranged according to age, it is found that there are 56 from one to two years, 33 from two to three years, 34 from three to four years, 10 from four to five years, and 11 which were five years old and over. The machines under one year old numbered 47. While there are many more tractors in the one- to three-year groups than in all the remaining groups, it must be remembered that the small numbers in the older group are due to the wearing out and discarding of many of the older machines and the purchase of new models.

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[1] Farmers' Bulletin 963, page 7.

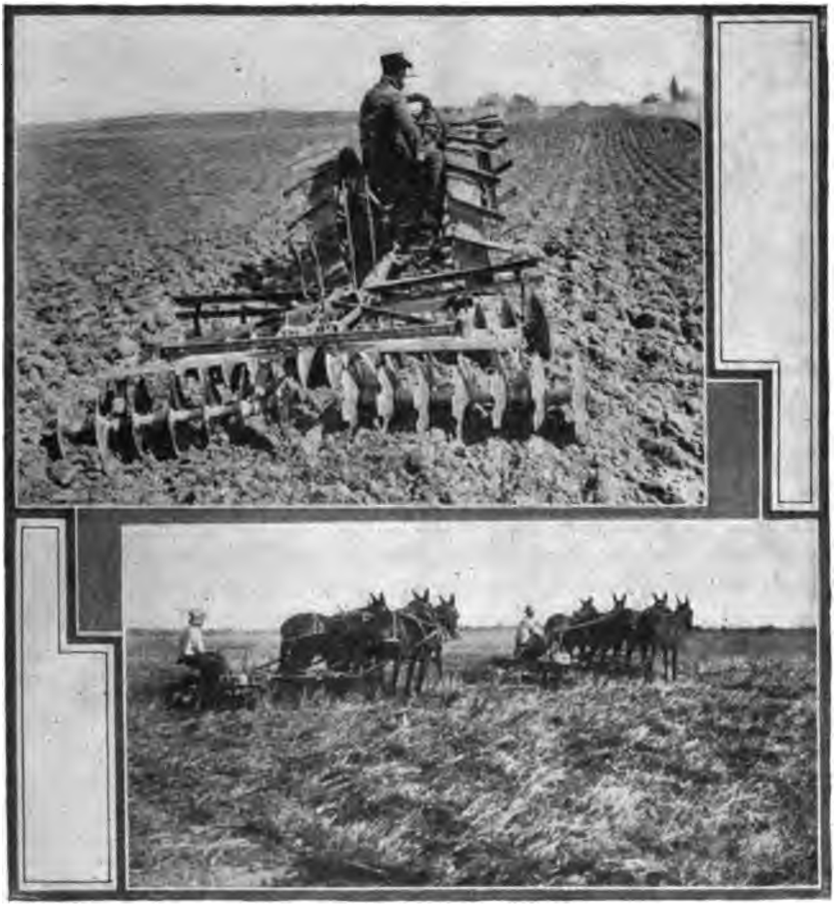

Fig. 2.—One man with tractor and double-disk harrow (upper) doing the work of two men and two 4-mule teams with two single-disk harrows (lower).

Age is closely related to size of tractor, for, as a general thing, the old tractors are the large tractors of five plows or over, while the new machines are the small tractors of two to four plows. The 56 tractors from one to two years old, the 33 from two to three years, and the 34 from three to four years averaged in size 2¾ plows, while the 10 which were four to five years averaged 3¾ plows, and those five years old and over, 6½ plows. Opinion, after some years wavering, seems to be settling on the 3-plow tractor as the logical machine for most farms, as it will be noticed from Table II that this size outnumbers all others.

TRACTOR OPERATIONS.

The farmer's main object in buying a tractor is to be able to do the heavy field work more quickly and easily than it can be done with horses, so that he can farm a greater acreage or handle his present acreage in a more efficient manner. It is noticeable that the men who have owned a machine for one year or less use it, as a rule, only for plowing and a little belt work. However, there are exceptions to this rule, for some who have owned machines less than a year use them on every operation possible, even outdoing the older operators on the total number of different uses. As a rule, however, the longer a machine is owned and the more experienced the operator becomes the more operations he finds the tractor can be used for. Here again, though not every use made of a tractor is a profitable one for all farms, each may perhaps be justified in individual instances.

In any section it will be found that plowing is the principal operation for which the tractor is used, and that, on the average, the days it is used in draw-bar work will outnumber those devoted to belt work. In gathering reports from tractor users it was the aim to list all of the different operations for which the tractor was used on each farm. The list of operations obtained brought to light some uses that were of a rather unusual nature. To both the experienced and the inexperienced operator a list of all these operations, both common and uncommon, should be of interest as suggestive of the possibilities of the tractor. (See fig. 3.) The largest number of different operations carried on by any one individual was 11, while several others used their tractors for 10 distinct operations. For all farms the operations averaged about 5, which seems low, considering what individual farmers have done.

List of operations in which tractor was used on 191 Corn-Belt farms follows:

DRAWBAR.

Plowing.
Listing.
Disking and spading.
Harrowing and planking.
Rolling and culti-packing.
Seeding grain.
Cultivating corn.
Loading hay.
Pulling hay fork.
Grain harvesting.
Corn picker and binder.
Manure spreader.
Moving buildings.
Road grading and dragging.
Building dike.
Clearing land.
Stretching fence.

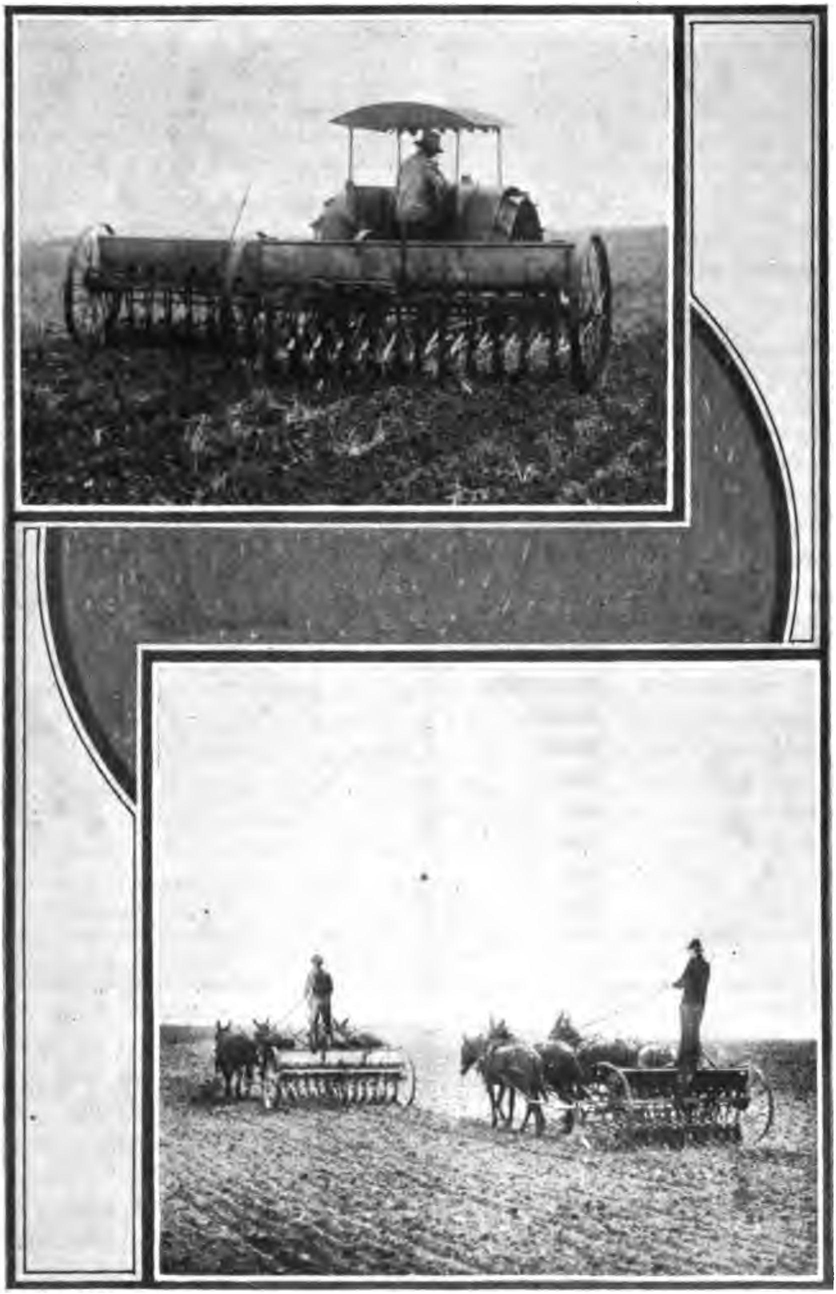

Fig. 3.—One man with tractor drilling wheat (upper) doing the work of two men and two 4-mule teams (lower).

BELT WORK.

Thrashing grain:
Hulling clover.
Elevating grain.
Shredding corn.
Shelling corn.
Ensilage cutter.
Baling hay.
Sawing wood.
Saw mill.
Cider mill.
Feed grinding.
Pumping water.
Pumping for irrigation.
Concrete mixer.
Tomato canning factory.

While many of the above operations are exceptional, they nevertheless show the large possibilities of the tractor as a source of power for farm work, as well as its adaptability to a large variety of uses.

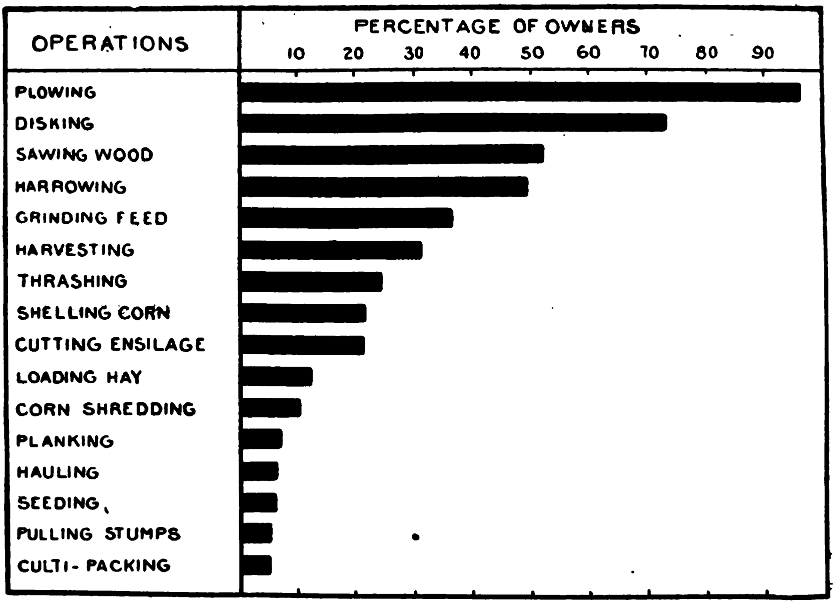

FIG. 4.—Various operations for which 191 tractors were used, showing the percentage of users for each operation. No operation carried on by less than 5 per cent of the operators is listed.

The principal operations on which tractors are used are small in number when compared with the entire list as given. Figure 4 shows the major operations for which 191 tractors were used and the percentage of owners using them in each case. Operations which were not performed by at least 10 tractors are not included.

As is natural to suppose, plowing leads all operations from the standpoint of number of users, with 96 per cent. The 4 per cent who did not use their tractors for plowing owned old machines which they had found too heavy for their conditions. It may be surprising to note that over 50 per cent used their tractors as a source of power for sawing wood, in many cases saving the expense of the purchase of a stationary engine to do this work.

One other operation may be cited because of its unusual character hitherto, that of loading hay. Twelve per cent of the operators used their machines for pulling the hay wagon and loader. Labor shortage was principally responsible for the size of this group, for the work was done with one man fewer than when horses were used. Each of the farmers seemed to be pleased with the results obtained and stated that it was his intention to continue the operation another year. All of these operators used the tractor with one wagon and loader. If two wagons and two loaders were arranged so that they could be pulled at the same time, as is frequently done, it would result in a still greater saving of time and labor.

While there is a great deal of objection on the part of some to using the tractor on prepared ground, especially after disking, it will be seen that nearly 50 per cent of the owners used the tractor for harrowing. In the case of planking and culti-packing, the number dropped to less than 10 per cent, but this is due to the fact that few perform these operations at all.

EXCLUSIVE AND COMBINED USES OF TRACTOR AND HORSES.

On very few farms are any operations now performed entirely with the tractor for which horses were formerly used exclusively. As shown in figure 4, most of the owners use their machines for plowing. Plowing should then no doubt show to a greater extent the number of operators using a tractor exclusively for any one operation. It was found that the older tractors shared the plowing with horses more than the newer machines. With the older machines, too, horses were used more often to finish up the fields. This is due to the fact that the newer machines are more easily handled in plowing out corners.

Nine operators stated that now they never have a horse in the field for plowing or disking and harrowing, while others used the tractor exclusively in the fall and horses to a great extent in the spring, because of moisture conditions. In some localities visited it was impossible to plow with horses in the fall of 1918 owing to unusually dry weather, which left the soil so hard that it was impossible to keep a horse-drawn plow in the ground. Under this condition the tractor user was working every day preparing the ground for winter wheat, while the farmer depending on horse labor was compelled to wait for rain to soften the soil. Such an interval of forced waiting may entail crop failure for the following season.

In considering the exclusive or combined use of the tractor and horses on farm operations, only those operations in which the two sources of power compete in a major way are considered. These are spring and fall plowing, disking, harrowing, and harvesting.

TABLE III.—*Number of operators who use tractors exclusively, horses exclusively, or both, for spring and fall plowing.*

Size of farm.	Number of farms.	Spring plowing.			Fall plowing.		
		Tractor only.	Tractors and horses.	Horses only.	Tractor only.	Tractors and horses.	Horses only.
Under 141 acres	10	8	1	......	4	1	3
141–220	36	14	12	2	16	9	5
221–300	35	13	19	1	16	13	3
301–380	16	7	6	1	9	4	2
381–540	18	9	6	1	8	8	1
541–700	16	2	5	3	10	5	2
701 and over	10	1	4	......	3	6	1
Total	141	54	53	8	66	46	17

To make possible a comparison of practices in these operations, 141 farms were arranged into 7 groups according to acreage, and classified according to utilization of tractor power and horsepower. (See Table III for plowing and Table IV for harvesting.) The weight of the machine will govern to a considerable extent its use in disking and harrowing, and it will be noted that on the larger farms, where as a general thing the tractors were large machines, tractors were not so generally used for this work as on the smaller farms with the lighter machines.

TABLE IV.—*Number of operators who use tractors exclusively, horses exclusively, or both, for harvesting.*

Size of farm.	Number of farms.	Harvesting.		
		Tractors only.	Tractors and horses.	Horses only.
Under 141 acres	10	2	1	6
141–220	36	7	3	26
221–300	35	8	2	24
301–380	16	4	3	9
381–540	18	3	3	12
541–700	16	3	4	9
701 and over	10	......	......	10
Total	141	27	16	96

These tables show that in each case the percentage of operators who use their tractor exclusively drops off rather gradually as the farms get larger, which is attributable to the inability of the tractor to do all of the work on these larger farms. In harvesting it is seen that on the very large farms the work is done entirely with horses. In the case of three operators this was due to the unwieldly size of the tractor, and in those of the remaining seven to an abundance of horsepower which otherwise would have been idle (fewer horses being displaced on these large farms than on any other group). While the use of a tractor saves horses in harvesting, it does not save in man power. With horses one man can handle the outfit, while with the tractor two are usually required.

Table V shows the same group of farms as Tables III and IV, classified according to practice in disking and harrowing. It will be seen that the number of exclusive tractor users is considerably smaller than for any of the other operations. This decrease in the exclusive use is mainly due to fear of packing soft ground, and to unfavorable moisture conditions in the spring.

TABLE V.—*Number of operators who use tractors exclusively, horses exclusively, or both, for disking and harrowing.*

Size of farm.	Number of farms.	Disking and harrowing.		
		Tractor only.	Tractors and horses.	Horses only.
Less than 141 acres	10	2	8	....
141–220	36	5	21	10
221–300	35	3	25	7
301–380	16	2	9	5
381–540	18	1	14	3
541–700	16	1	9	6
701 and over	10	....	6	4
Total	141	14	92	35

One hundred and six farmers used their tractors for disking and harrowing, while for fall and spring plowing and harvesting the numbers are 112, 107, and 43, respectively. The average number of days' work spent on each of these operations in the order that they are given above is 6.9, 8.9, 7.2, and 3.9. At the same time on these farms 20.2, 8.4, 6.3, and 5.5 horse days also were required for the respective operations. These figures would tend to show that where the conditions are at all favorable the operator will use the tractor as much as possible.

It will be of interest to note further that, of the operators who used only tractors for disking and harrowing, the majority used two-plow machines, the remaining few using three-plow. The operators who used their tractor in conjunction with their horses had machines which averaged three plows, while those who used only horses for these operations, owned tractors which averaged four plows. Size of tractor would, therefore, seem to be significant if it alone is to be used for disking and harrowing, or if its use in conjunction with horses, which seems to be the most common practice on these farms, is contemplated. The use of the tractor with horses is not only the most common practice, but in most cases the most practical, as soil conditions in the spring are not always ideal for use of the machine.

ANNUAL USE OF TRACTOR AND HORSES.

The days in a year that any machine is used depend upon a combination of conditions. If the tractor is used as the source of power for belt work, instead of a stationary engine, the total number of working days will be increased considerably. Again, seasonal and weather conditions will influence the days used annually.

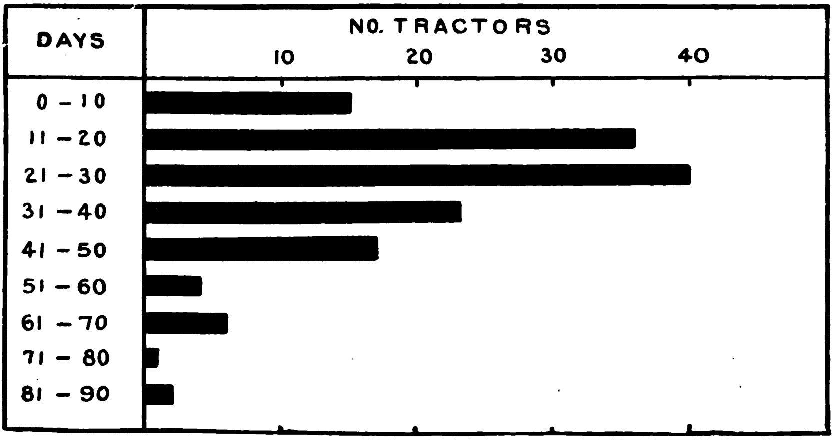

FIG. 5.—Number of days 144 tractors one year old, or more, were used annually.

In determining the number of days that the tractor was used annually, an effort was made to ascertain the number of full days' work. It was noted that in giving figures on number of days' work operators often called fractions of days whole days. For example, where feed was ground two days each week during the winter months, the number of days' work done was given as two days a week, when in reality the tractor was run only two hours each day, or less than one-half a day per week. It was necessary, therefore, to reduce all working time to a 10-hour day basis, as was the case in arriving at the time a horse works annually on the average (100 days).[1]

In computing the days used annually, no tractor less than one year old was considered, so that a full years' work for each machine is represented. In figure 5 is shown the number of tractors and the days they were used on the home farm for drawbar and belt work.

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[1] See U. S. Department of Agriculture Bulletin 560.

It will be seen that the greatest number of operators used their machines between 21 and 30 days annually, the average number of days used per year for all being 29, for draw-bar work 20, and for belt work 9. Many reports have been published and given wide publicity in regard to men who are said to operate their tractors from 100 to 200 days annually. Considering necessary time out for bad weather, Sundays and holidays, moving, maintenance, repair, and time required by other work, it would seem that these figures are extreme.

The age of the tractor does not seem to influence to a great extent the number of days used annually. The figure is uniform for the machines of one, two, and three years, while it drops off about three days for machines of four years and over. This falling off is explained by the fact that the larger machines are in this class and that they are being used less and less for field work, though the time they are used on belt work remains fairly constant.

DISPLACEMENT OF HORSES.

There seems to be a general impression that the use of the tractor will eliminate a large percentage of the horses kept on the farm. However, this has not proved to be the case up to the present time, except in a few scattering instances. (See Table VI.) Too many are misled by the broad statements that are circulated regarding the importance of the tractor in the matter of horse displacement and lose sight of the major advantage of the tractor, namely, its ability to do heavy work and cover the desired acreage in a shorter time than the same can be done by horses. If this fact were generally realized, many a man who has sold his horses upon purchasing a tractor (or even before, as did two of the men under consideration) would have hesitated to do so until he found out just what it was possible to do on his farm with the tractor and what would remain to be done with horses.

TABLE VI.—*Horses displaced by tractors on farms on which tractors had been used one year or more.*

Number of farms	141
	Average.
Number of horses before buying tractor	9¾
Number after buying tractor	7¼
Number displaced	2½
Acreage per horse before buying tractor	35½
Acreage per horse after	47¾

It should be borne in mind that even the best tractor is not suitable for all the necessary operations on a Corn-Belt farm or on any other type of farm, for that matter. It will therefore be necessary to keep enough horses to carry on the operations that it is not possible to do with the tractor.

The market for horses was relatively weak when this inquiry was made, and consequently many horses have been kept on farms where tractors were owned, which otherwise would have been disposed of. This fact will have a bearing on the number of horses displaced on these farms. Often, when the question of how many horses had been disposed of was asked, the reply was: "I could spare more, but the price is so low that I can not afford to sell them."

A significant feature brought out by the inquiry was the lack of colts on these farms. The production of colts, formerly an important side line, seemed to have been practically abandoned, raising a serious question as to the source of the future supply of horses. The reason for this was twofold, the low price paid for horses and the high price of feed. The average cost of feed for horses on these farms was 39 cents per head per day, or $142.35 per year, a considerable increase over prewar prices. If the same horses were to be kept in town, the cost of the feeding would be around 55 cents per day, or $200 per year, the difference being due to the pasturage and cheap feed on the farm which it is not possible to obtain in town. With this high price of feed per year, it will be seen that horses are kept at a loss unless they are doing some productive work a large share of the time. The cost of feeding a horse seems out of proportion to his value, as the average price of the horses displaced on all of the farms was but $161, which figure can also be assumed as the average value of those that were retained, as it was not the poorest horses which were sold, but those of about average quality.

On the farms which had had tractors in operation for one year or more (average acreage 346½) the number of horses displaced averaged 2½. (See table VII.) The acreage per horse before and after was 35.5 and 47.8 acres, respectively, an increase of 12.3 acres per horse. It should be remembered that there was an average increase of 22 acres in the size of the farms after the purchase of tractors.

The number of tillable acres per horse, both before and after the purchase of the tractor, increased from the smaller to the large farms. The increase in percentage of acres per horse, however, is considerably larger for the smaller farms than for the largest group where the number of acres per horse is greatest. The former were keeping more horses than were necessary, while the latter had nearly the minimum number required for their needs before buying a tractor.

TABLE VII.—*Tillable acres per horse before and after the purchase of the tractor and the percentage of increase in each case.*

Size of farm.	Number of farms.	Tillable acres per horse before purchase of tractor.	Tillable acres per horse after purchase of tractor.	Per cent of increase in tillable acres per horse after purchase of tractor.
Under 141 acres	10	18.8	31.5	68
141 to 220 acres	36	22.6	31.4	39
221 to 300 acres	35	23.7	32.3	41
301 to 380 acres	16	23.6	37.4	58
381 to 540 acres	18	23.9	42.3	77
541 to 700 acres	16	31.2	44.1	44
701 and over acres	10	42.2	50.0	19
All farms	141	26.5	38.5	45

The size of the tractor has no uniform bearing on the number of horses displaced and, therefore, can not be used as an index of possible horse displacement when purchasing a machine. The tractor most suitable to the particular needs of the farm should be considered and not its advertised rate of horse displacement.

At the present stage of development the age of the tractor has a very definite bearing on the rate of horse displacement. Though there is a tendency on the part of some owners at first to sell more horses than they should, with the result that it is necessary to rebuy, these men are greatly outnumbered by the more careful operators who are slow to dispose of their horses until they are sure of what can be done with the new outfit. Usually the original purpose in buying a tractor is to do the heavy work, such as plowing, but other uses are soon found as the operator becomes more accustomed to its use and operation.

Reference has been made to the fact that enough horses will have to be kept on the farm to carry on the operations for which it is not practicable to use the tractor. An exception might, however, be noted where it would be cheaper to hire an extra horse or two for a short period to carry the work on rather than keep them at a big expense throughout the year for the short period when needed. It was found that 22 men did just this thing, finding it a great deal cheaper to hire than own. This practice was highly recommended by some, as it saved a team and the necessary cost connected therewith, including investment, harness, feed, and care. Help being scarce, many said it was their only way of obtaining an extra man when needed. Most men who team for hire will not hire out their teams alone. It was the general opinion that a man and team could be hired relatively cheaper than a man alone, and this opinion is borne out by the prices paid by the majority of men who hired, which was but $5 to $6 per day for one man and a team for cultivating corn, haying, or harvesting. Even paying more for a man and team is certainly cheaper than carrying over an extra team for these operations, providing, of course, that it is possible to hire the labor in the particular community.

EFFECT OF CORN ON THE DISPLACEMENT OF HORSE LABOR.

On 116 farms, each containing 20 or more acres of corn, it was found that 29 were operated with four horses, the acreages in corn ranging from 20 to 119 acres; 26 by six horses, corn acreage 40 to 199; and 15 by eight horses with corn acreages of 40 to 199. All other groups contained fewer than ten farms. Only four farms were operated with two horses, with corn acreages ranging from 20 to 59. In all, 23 farms were operated with odd numbers of horses. The average acreage of corn per horse for this group was 14.

Of 138 farms on which corn occupies a greater acreage than any other crop, 59 had ten acres of corn or under per horse; 44 had 11 to 15 acres; 26 had 16 to 20 acres; and 9 had 20 acres and over. The tendency is strongly toward a smaller number of acres per horse than 20, the number usually figured on. When these same farms are arranged according to the per cent of tillable acres in corn, it is found that the number of tilled acres per horse decreases as the area in corn increases, with but one exception. In other words, the greater the area in corn the fewer horses displaced. This can be attributed to no other reason than that it is necessary to keep enough horses to cultivate corn and do other necessary horse work at corn cultivating time. Until corn is cultivated with a motor cultivator, of which there are several now on the market, it will be necessary to keep these horses, as the ordinary tractor is not suitable for this operation. Many of the farmers interviewed said that if it were not for corn cultivating, more horses could be displaced.

It would seem, therefore, that after eliminating horse labor to a large extent from spring work, the next problem would be to do the same for cultivating by using two-row machines or motor cultivators. At any rate it is clear that, in determining the number of horses that will be displaced by the tractor, it will be necessary first to determine the number of horses required to cultivate the usual corn acreage and carry on the other necessary work coming in these periods.

INFLUENCE OF THE TRACTOR ON DISTRIBUTION OF HORSE LABOR.

Farms of the Corn Belt should offer almost ideal conditions for using the tractor. Not only is the topography generally favorable, but the operations for which the tractor is best fitted (those which require the greatest amount of horse labor in the shortest possible time, namely, the preparation of ground for spring crops) are the operations which require the greatest amount of drawbar work on a Corn-Belt farm (fig. 6). It has been shown that it is necessary for a horse-operated farm to carry enough horses throughout the year to carry on the work during the spring rush.

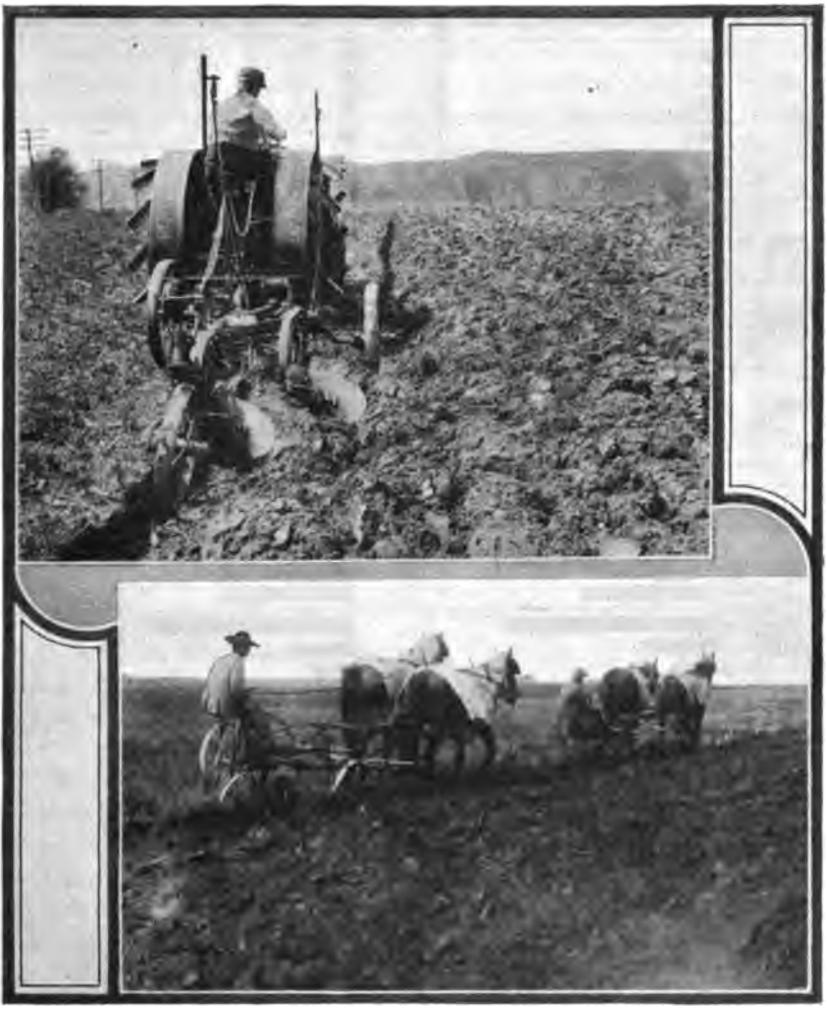

FIG. 6.—One man, with tractor and two-bottom plow (upper) doing the work of two men and two 2-horse teams with two 1-bottom sulky plows (lower).

In figure 7, in the left-hand column, is shown the distribution of horse labor throughout the year on an ordinary Corn-Belt farm of 200 acres.[1]

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[1] Thanks are due to Mr. J. S. Ball of the Office of Farm Management, U. S. Department of Agriculture, for the data used in compiling the left-hand column of figure 7

It will be seen that the greatest amount of horse labor comes late in April and consists mainly of plowing for corn and the various operations involved in getting the oats crop sown. The next three large 10-day periods, covering the month of May, are in the main devoted to the preparing of corn ground and corn planting. Corn

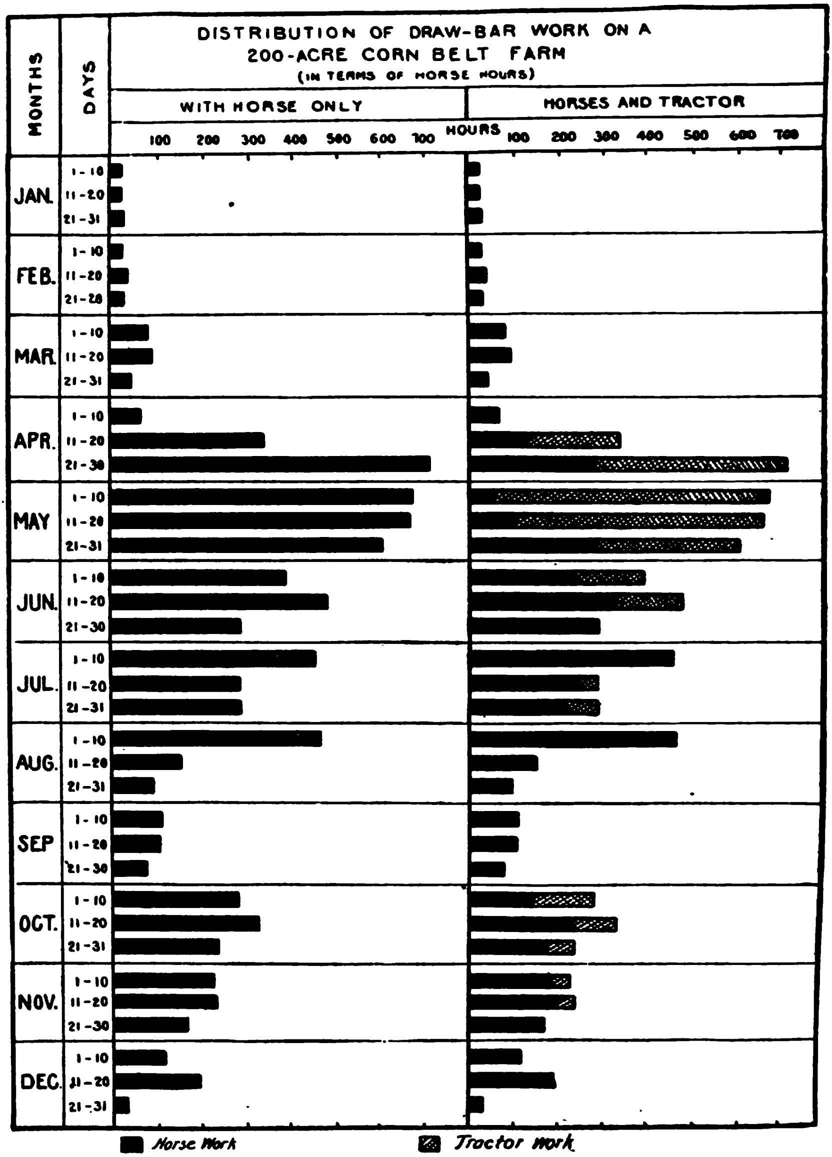

FIG. 7.—Distribution of drawbar work on a 200-acre Corn-Belt farm. Left: Horse labor for year by 10-day periods. Right: Same for horses and tractor, shaded portion of bars representing horse labor eliminated by maximum substitution of tractor for horses.

cultivating is spread over the period from June 1 to August 1, and at no time does it approach in intensity the work required for preparation of the soil.

The work required on this farm during the heavy 10-day period in April amounted to 711 horse-hours. With two days out of the period for Sunday and inclement weather, there remained eight working days of 10 hours each. With nine horses, the number on this farm, each working every day, it would have been possible to put in a total of 720 horse-hours in the eight days. This would necessarily mean that no time be lost, as the margin is small. In the spring, during this rush period, it is usually the custom to put in a greater number of hours per day in the field than 10, so that no time be lost in getting the ground in shape for crops.

The month of May requires nearly as great an amount of horse labor for each 10-day period as is required in April, for there will be days when no field work can be done. During this 40-day stretch of heavy horse labor the nine horses on this farm are seldom idle. It would not be necessary, however, to use this number for corn plowing or for any other operation during the remainder of the year, as six horses are capable of doing any work necessary after the crops are in. Immediately after the corn is planted the horses can be worked alternately on the various operations, which would give each the usual needed rest after the heavy spring work.

The greater part of the work in the 10-day periods of June 11–20 and July 1–10 is corn cultivating, and as there is little competing work during that time there is no rush of work to be done in a short period. Thrashing takes most of the time during the 10-day period of August 1–10. This includes return labor to neighbors who help in thrashing on the home farm. After the August period the work for nine horses is very light, and they are consequently idle a great share of the time.

In the right-hand column of figure 7 is shown the estimated maximum horse labor which a tractor could replace on this same farm. With the tractor doing all the work for which it is suited, a considerable amount of horse labor would be eliminated. The black area in this column shows the number of hours labor that it would still be necessary to do with the remaining horses, while the shaded area shows the number of horse hours which the tractor would eliminate while doing the same work in considerably less time.

If a tractor were used, the peak load for horse labor would come during the first 10 days in August. The larger part of this work is thrashing and is all done in two days' time. It is not usually necessary, however, to have horses enough to carry the work over this period, since extra teams are ordinarily furnished by neighbors in the customary exchange of labor in thrashing. The number of horses necessary to keep would then depend upon other factors, and it is found that the largest amount of horse labor absolutely required would be that demanded during the periods of June 11–20 and July 1–10. Most of this work is corn cultivation, and to be perfectly safe six horses would be necessary to do the work, as there are 108 acres of corn on the farm. Thus three horses safely could be disposed of and still leave enough to do all the necessary work.

A still further indication of what the effect of the tractor on this farm would be is given by the following figures: The total number of days which the nine horses worked on this 200-acre farm in one year was 850, or an average per horse of 94½ days per year, which is close to the 100-day average usually given. With the addition of a tractor doing the work for which it is suitable 321 days of horse labor would be eliminated, which would then leave 529 days of labor still requiring the work of horses to perform, while the tractor does the remainder. If three horses are disposed of there would be left 88 days of labor per year for each of the remaining six horses, or 6½ days less labor per horse than before.

Of the entire amount of tractive work done during the year, the tractor would do approximately 38 per cent and the horses the remaining 62 per cent. It must be understood that the work which the tractor is here represented as doing is the maximum amount that possibly could be done on the drawbar on this farm, and on few farms, if any, would the full amount here shown be done. Within reasonable limits the difference between the possible maximum and the actual amount of work performed by the tractor could well be taken care of by the six horses, which would act as an auxiliary source of power at all times, and be able to help out in most of the emergencies that might arise. Further, there would be work for the tractor on the belt, but this is not ordinarily a competing-horse operation, so the number of days' belt work is not considered.

Considering the acreage covered and the time required by the tractor on various major operations with reference to the work formerly done by horses, it is found that a 3-bottom tractor would, in the same time, all conditions being equal, do the work of 8½ horses. However, it should not be taken that the tractor will displace this number of horses. At this rate the plowing, disking, harrowing, and harvesting which would take the entire nine horses about 36 days to do could be done with the tractor alone in about 38 days of 10 hours each. Thus it will be readily seen how with the tractor it is possible to increase the size of the farm without hiring more man labor, as many operators do; for, as stated before, one man is able to handle more acres with a tractor than with horses in a given time.

Attention is now directed to the results which have been obtained on the entire group of farms as compared with those shown for one farm in figure 7. It should be remembered that in the case of the one farm cited, the principal crops were corn, oats, and hay, while in the large group the averages reflect the influences of various cropping systems. The number of days of horse labor required per year for all operations since the advent of the tractor was ascertained for each of the farms, so that a comparison could be made of the days of tractor work and of horse work.

The number of days of horse labor expended annually on the 141 farms, averaging 346 acres, upon which a tractor had been in operation one year or more, was 566, or an average per horse of 78 days per year. This figure as compared to the 94½ days on the 200-acre farm is low, and indicates that the horses were idle too much of the time. This bears out the surmise that more horses might have been sold from these farms had the market price been high enough. If now the average number of horses on these farms were reduced by one, the number of day's work for the remaining horses would then be 90½ per year, which would be near what it should be and still leave a margin of safety, for it is considered that, on the average, a horse works approximately 100 days annually in the Corn Belt.[1]

The drawbar work that the tractor is doing, expressed in terms of horse-days, amounts to but 172¾ days annually, which would indicate that many machines are falling far below the maximum amount of work a tractor can do, in view of the possible elimination of horse labor on the above-cited 200-acre farm (321 horse-days). This is accounted for by the fact that there are many old machines which are too heavy to work on preparing ground and related operations, and which are used for plowing only. The newer and lighter machines show a considerable higher average number of days' drawbar work per year than the general average.

The average share of the drawbar work that the tractor does on these farms is approximately 25 per cent, which leaves 75 per cent for the horses to do as compared to 62 per cent for the horses and 38 per cent maximum for the tractor as estimated for the 200-acre farm above cited.

USE OF HORSES WHILE TRACTOR IS IN OPERATION.

With the high price of feed (see p. 18) it is now more important than ever before to obtain the maximum amount of work from the horses which remain on the farm after the purchase of the tractor. Of course, there is only a certain amount of productive work to be done on any farm without a change of organization, and when this is completed there is nothing left for the horses but to stand idle.

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[1] U. S. Department of Agriculture Bulletin 560.

During the seasons when the greatest amount of horse labor is required, it is not a very difficult task to find enough profitable work to keep the work animals busy, but the problem of keeping the horses profitably busy when the tractor is in operation is one that will tax most farmers to solve. If the farm is being operated by the farmer alone, there will be no solution for the problem of idle horses unless he has boys large enough to handle a team for minor operations. If a hired man is employed, the problem will be nearer to solution. As stated before, the tractor eliminates hired help to a certain extent, as well as horses, both depending on size of the farm.

To ascertain what operators are doing with their horses while their tractor is in operation the question was asked of each, "What use do you make of your horses while you are operating your tractor?" The answers received to this question are summarized below, and no doubt they will be of interest to other operators who find trouble in keeping their horses busy at this particular time.

From 177 reports it was found that only 16 operators allowed their horses to stand idle while the tractor was being used for drawbar work, 85 reported that their horses were idle part of the time, and 76 said their horses were fully occupied. Of the 85 reporting their horses idle part of the time, 30 reported that they did some hauling on the road or used them on the manure spreader, but most of the work reported consisted of plowing, disking, and harrowing. In the cases of the 76 reporting their horses fully occupied, plowing, disking, and harrowing constituted the major part of the work done.

CONCLUSION.

It will be evident from the foregoing that the most important effect of the introduction of the tractor on the horse-labor schedule is the shifting of the peak load of horse labor from the spring season to the corn cultivating season. It has already been pointed out that the work of thrashing, which appears as the peak in figure 7, is not so heavy as it looks, since it is done by the usual exchange of teams. The real peak load that remains after the tractor has assumed the burden of the preparation of the land falls in the period of June 11 to July 29, when corn cultivation is at its height. Certain other farm operations require drawbar power at the same time, some of which can not be done by the tractor. Hence, the following general rule may be laid down with regard to the number of horses that it is necessary to retain on the farm after buying a tractor:

Keep enough horses to cultivate corn and do other necessary work which must be done at the same time, but which the tractor can not do.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

Farmers' Bulletin 1094 A 1.9: 1094
United States Department of Agriculture

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The Alfalfa Caterpillar

THE YELLOW BUTTERFLIES of the alfalfa caterpillar are found over most of the United States, but they are not always recognized as the adult stage of the "green worms" that cause so much damage in the extensive alfalfa-growing sections of the Western and Southwestern States. The larvæ, or "worms," feed on the leaves and the tender terminal buds, and in cases of severe infestation eat a portion of the stem also.

Each female butterfly lays from 200 to 500 eggs, and as the period of development in the warm Southwest is very short, immense numbers of the destructive caterpillars are found. It is estimated that they cause a financial loss approximating a million dollars a year in alfalfa fields in California and Arizona alone.

The farmer who is on the alert can prevent an outbreak, or can reduce the damage from an infestation, if he learns to recognize the various stages of the pest, described in this bulletin, and to employ control measures as outlined in pages 12 to 16. Clean cultural methods, well-regulated irrigation, and cooperation with neighbors, if consistently followed, will minimize and, at times, totally eliminate the damage from this insect.

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief
Washington, D. C. April, 1920

THE ALFALFA CATERPILLAR[1]

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Entomological Assistant, Cereal and Forage Insect Investigations.

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THE ALFALFA CATERPILLAR is one of the most destructive insect pests of alfalfa in the southwestern United States. In 1914 a complete report[2] of the life history of this caterpillar, together with the methods of control, was published. The present paper contains additional information relating to methods of controlling the pest by the management of irrigation water as well as a brief account of its natural history, and is intended to meet the ever-increasing demands of ranchers and others for assistance in protecting their alfalfa against these "green worms."

DESCRIPTION.

In order to foresee an outbreak of this pest and adopt suitable control measures, it is first necessary to be able to recognize the different stages of this insect.

There are four of these, namely, the egg; the larva, or "green worm" stage; the pupa, or resting stage; and the adult, or butterfly stage. A great many farmers fail to recognize the "green worms" in their alfalfa as the young of the thousands of yellow butterflies that were flitting over their alfalfa fields a week or 10 days before. In order that the alfalfa grower may become acquainted with and learn to recognize these different forms, the following descriptions are given:

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[1] *Eurymus eurytheme* Boisd.

[2] Wildermuth, V. L. The alfalfa caterpillar. U. S. Dept. Agr. Bul. 124. 1914.

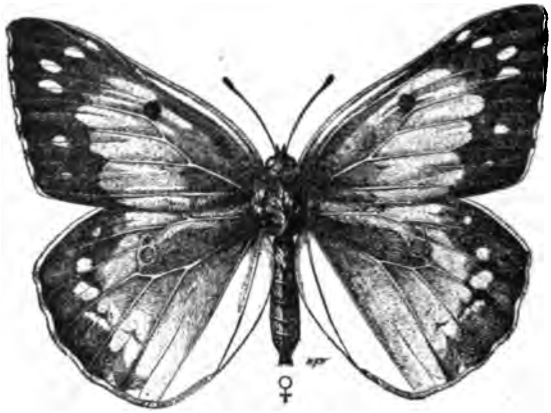

FIG. 1.—The alfalfa caterpillar: Female in adult, or butterfly, stage. One-half enlarged.

The adult (fig. 1) of the alfalfa caterpillar is a very beautiful yellow butterfly about 2 inches wide from wing tip to wing tip. The under surface of the wings and the part visible when the butterfly is at rest are a solid light yellow color, while the upper wing surface is bordered by black. The male (fig. 2) may be distinguished from the female (fig. 1) by the fact that the outer border of the wings is solid black in the former but broken by a line of yellow splashes in the latter. White "freak," or albino, specimens are frequently noticed.

The egg (fig. 3) laid by the female is six one-hundredths of an inch long. It is elongate, white when laid, but turning reddish brown after the second day, and is deposited upright with the basal end attached usually to the upper surface of the leaf.

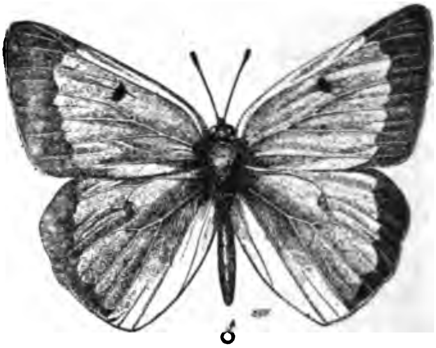

FIG. 2.—The alfalfa caterpillar: Male in adult, or butterfly, stage. One-half enlarged.

The larva, or "green worm," when first hatched, is a tiny, dark brown, cylindrical object which soon after feeding takes on a green color. Growth is rapid and the larva (fig. 4), after having shed its skin, or molted, four times, is a little more than an inch in length and is of a dark grass-green color, with a white stripe on each side of the body, through which runs a crimson line. There is often an intermediate, narrower, broken, and less distinct white line just above each of the lateral lines. In some specimens a black or dark green median dorsal line is also present.

The pupa (fig. 5) is yellowish green, with a conspicuous row of black dots just within the margin of each wing pad and three black dots on each side of the abdomen. It is free, having no cocoon, and is found, head up, attached closely by its posterior end to an alfalfa stalk or other support with the anterior end hanging loosely in a threadlike swing which is joined to the same support.

DISTRIBUTION.

The yellow butterflies of the alfalfa caterpillar are found over most of the United States. In the Mississippi Valley (see map, fig. 6) and some of the Southern States these caterpillars are often abundant, but they are found in destructive numbers and doing their greatest damage to alfalfa throughout the sections of the Western and Southwestern States where irrigation is extensively developed. The irrigated valleys of Arizona and California are visited yearly by this pest.

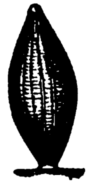

FIG. 3.--Alfalfa caterpillar: Egg, greatly enlarged. (Redrawn from Scudder.)

ECONOMIC IMPORTANCE.

As has already been mentioned, these caterpillars are present in destructive abundance nearly every year in some portion of the Southwestern States. In the Imperial and San Joaquin Valleys of California and in the Yuma, Salt River, and Gila River Valleys of Arizona, they prevent the maturing of many tons of hay. Some years only very small sections or even individual fields may be seriously infested and an entire crop destroyed, but other years the outbreak becomes widespread and, if control measures are not used, takes the major portion of one cutting of hay over the entire area. It is safe to estimate that from 25,000 to 60,000 tons of hay are destroyed in a year in the two States of California and Arizona alone. This means a financial loss of a half million to a million dollars that year.

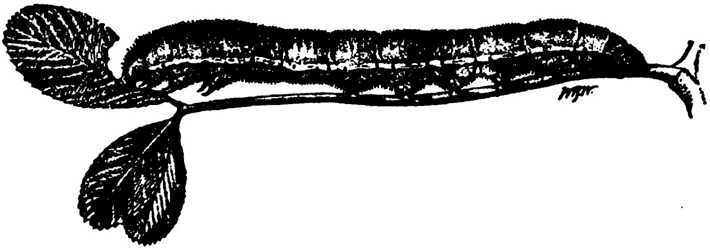

FIG. 4.—The alfalfa caterpillar: Full-grown larva. Enlarged about three diameters.

The energetic and up-to-date farmer can greatly reduce, and at times totally eliminate, this damage if he will only acquaint himself with the habits of the insect and the methods of control.

INJURY TO THE ALFALFA PLANT.

The injury to the alfalfa plant is caused by the larvæ feeding. The very small larvæ eat holes in the leaves, but after only a few days' growth they consume the whole leaf and the tender terminal buds.

In severe outbreaks a portion of the stem may also be eaten. The adults feed on the nectar of the blooming plants and in no wise injure the plant, leaving that to their destructive young—the larvæ, or "green worms." In cases of very heavy infestation the decayed remains of worms killed by a disease (which will be discussed later on) often impair the quality of the harvested hay, and thus cause an additional loss.

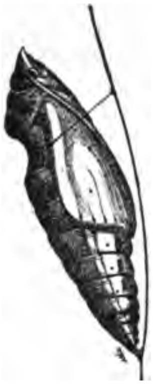

FIG. 5.—The alfalfa caterpillar: Chrysalis, or pupa.

SEASONAL HISTORY.

This insect usually passes the winter season in the pupal stage (see fig. 5), although in the Southwest both larvæ and adults have been taken during every month of the winter. These pupæ are often found on waste alfalfa along fence rows, ditch banks, or other places. (See fig. 12.) A great many of these overwintering helpless pupæ are destroyed either by their natural enemies or by climatic conditions. The rancher can assist in this destruction of pupæ by cleaning up all fence rows, ditch banks, and other waste places.

During the months of February and March, adult butterflies issue from the overwintering pupæ. The butterflies soon lay eggs from which hatch the green worms, which in turn, by the end of May, produce more butterflies. Following this there is a generation about every 30 days, so that, if left unmolested, by July or August the butterflies are present in surprising numbers. Thus, there are from three to seven generations each year, depending on location and climatic influences.

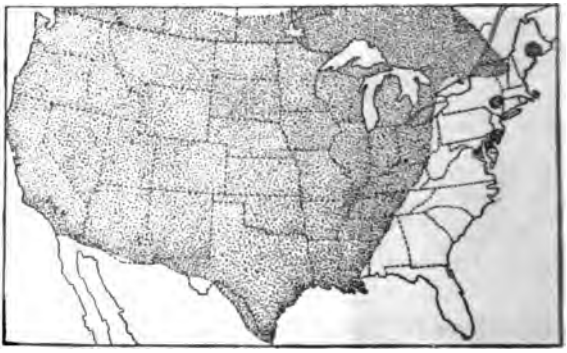

FIG. 6.—Map showing distribution of the alfalfa caterpillar.

THE EGG.

The eggs may be found on the upper surface of alfalfa leaves. There may be several on a single leaf, although they are usually laid singly. These eggs hatch in from three to seven days. The rancher should be on the lookout for the eggs and watch the development of the young hatching therefrom, so that he may be prepared to start control measures should these become necessary.

THE LARVA.

The larvæ or caterpillars grow very fast during warm weather and often become full grown within 12 to 15 days after hatching, having increased during this time from less than one-tenth inch to nearly 1½ inches in length. The larva is often difficult to see as it stretches itself along an alfalfa stalk, the green color of its body being about the same shade as the alfalfa upon which it is feeding.

THE PUPA, OR CHRYSALIS.

The pupæ (fig. 5) are found hanging, head up, attached to alfalfa or other stems, and as their color blends with their environment they are often difficult to distinguish, and may be overlooked unless carefully sought. Often, too, instead of pupating on a bare stem the larvæ crawl to a leafy stem and pupate there, thus protecting themselves still further from their enemies and from the rays of the sun.

This is a resting period of about five to seven days, during which the caterpillar is transformed to a butterfly. Throughout it the pupa remains almost motionless and is suspended from its support by slender silken threads.

THE ADULT, OR BUTTERFLY, STAGE.

The adult butterfly usually emerges from the pupa early on a bright morning. It crawls up any convenient support, quite soon spreads and dries its wings, and is off looking for bloom upon which to feed. The sexes often mate the same day they issue but usually the second day, and in another day the female begins to lay her eggs. She lays from 200 to 500 eggs during her brief life of about two weeks. This large number of eggs and the short period of development in the warm Southwest account for the occurrence of immense numbers of these worms. Suppose a female issues from its winter home in March and lays 400 eggs. By the end of May, if all her eggs hatched and the young all grew to maturity, there would be 400 butterflies, of which half, or 200, would be females. These would produce 80,000 adults by the end of June, 16,000,000 by the end of July, and 3,200,000,000 by the end of August. Thus the destruction of a female pupa in February in reality obviates the possibility of the development of more than 3,000,000,000 larvæ and their attack upon the alfalfa during July and August.

The female butterflies nearly always search out young and tender growing alfalfa for their egg laying. Hence, the eggs are more often found on alfalfa when it is from 2 to 8 inches tall. It is, therefore, necessary to keep a lookout for caterpillar eggs only on alfalfa of this size.

FOOD PLANTS.

These caterpillars feed upon a variety of different plants, but alfalfa seems to be their favorite food plant and the one that is most seriously injured by them.

THE VALUE OF NATURAL ENEMIES IN REDUCING OUTBREAKS.

Were it not for the fact that this species is preyed upon by a great many natural enemies it would indeed prove a much more serious pest than it actually is at present. Parasites and predacious insects, fungous and bacterial diseases, birds, toads, and even domestic fowls. all play a large part in keeping the species within bounds.

PARASITES.

A very small parasite[1] destroys the eggs and often as many as 50 per cent of them fail to hatch because of its work. A butterfly egg thus parasitized turns black instead of the natural reddish brown.

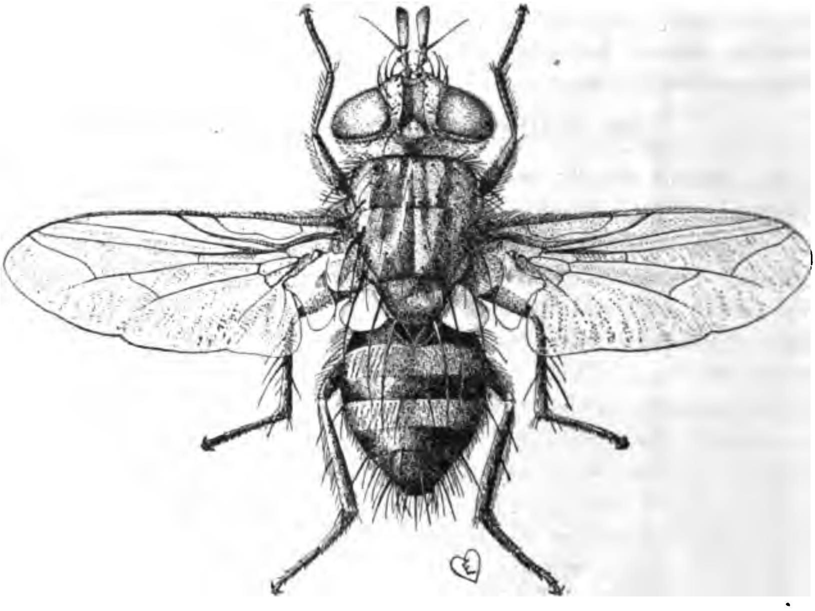

FIG. 7.—*Phorocera claripennis*, a parasite of the alfalfa caterpillar: Adult. Enlarged.

Several kinds of parasitic flies[2] often prey upon the caterpillars or young. One of these flies is pictured in figure 7. The white eggs from this fly are deposited on the half grown worms. Their white color makes them very conspicuous spots on the green-colored worms. A tiny maggot hatches from one of these eggs and immediately works its way into the caterpillar. Here it feeds and grows gradually, eating out the interior of the green worm, which soon dies.

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[1] *Trichogramma minutum* Riley.

[2] *Phorocera claripennis* Macq., etc.

Another parasite[1] which is of importance in controlling this caterpillar is shown in figure 8. It is a minute black insect that lays its eggs within the pupa or resting stage of the caterpillar. These eggs hatch into tiny grubs (fig. 9) which eat out the interior of the pupa. Later the adult insects gnaw holes in the empty pupal shell and crawl out, as is shown in figure 10. Some years 60 per cent of the pupæ are destroyed in this way.

The bollworm[2] (fig. 11), which is ordinarily an injurious worm on corn and cotton, feeds upon both the caterpillars and pupæ of this butterfly.

A CATERPILLAR DISEASE.

The most important enemy of this caterpillar, however, is a disease, probably of bacterial origin, which is quite common upon both the caterpillars and pupæ. At times (evidently during periods of high humidity accompanied by warm weather, as in July and August) it becomes so widespread as to kill a great majority of a brood and often nearly annihilates it. This disease is by far the greatest natural check against which the alfalfa caterpillar has to contend. The worms when first attacked take on a lighter green

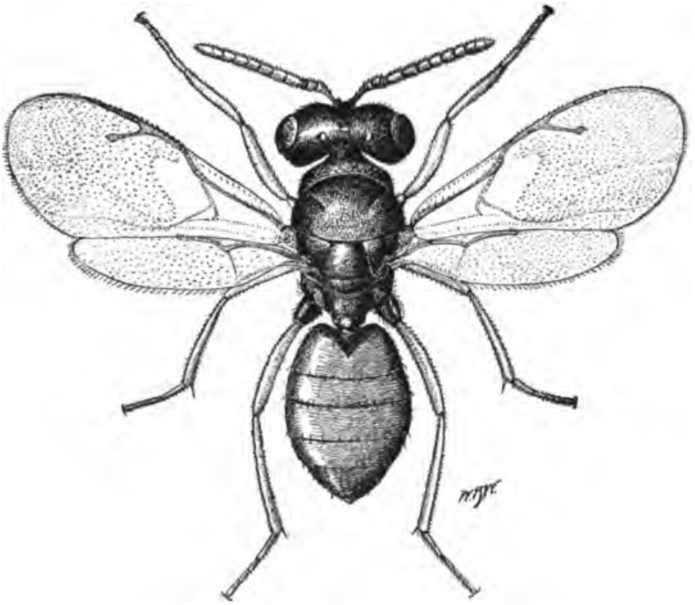

FIG. 8.—*Pteromalus eurymi*, a parasite of the pupa of the alfalfa caterpillar: Adult. Greatly enlarged.

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[1] *Pteromalus eurymi* Gahan.

[2] *Chloridea obsoleta* Fab.

color and become sluggish; but in a few hours they change to a brownish black and melt down into a decaying mass.

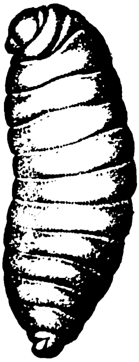

FIG. 9.—*Pteromalus curymi*: Larva. Greatly enlarged.

The dead worms, which are nothing but soft decayed masses found hanging to the alfalfa stalks, are sometimes very numerous. Frequently, where a hay crop is not totally destroyed by a brood of caterpillars before they are killed by this disease, the decayed remains on the hay become so foul as to render the hay quite unpalatable for horses and, hence, of low feeding value.

As has been suggested, the development of the diseased condition in either larva or pupa depends largely upon moisture. The disease is present at all times, but it is only when a period of high humidity accompanied by warm weather occurs that it becomes so prevalent as to attack the worms in large numbers. It has been found that at certain times these conditions of moisture may be produced artificially by irrigation, and the disease, thus fostered, is utilized as a factor in controlling the pest. That the disease does not at all times keep the caterpillar in check is doubtless due to the dry climate of these Southwestern States, and a comparison of the conditions in the Imperial Valley of California with those in the Salt River Valley of Arizona supports this view. The Imperial Valley is unique in topography, being below sea level, and having an average rainfall of probably less than 2 inches annually, while the Salt River Valley has an elevation of some 1,200 feet and an annual rainfall of about 8 inches. The outbreaks of the alfalfa caterpillar in the two valleys vary inversely with the rainfall. In the drier Imperial Valley the outbreaks are more numerous and severe and the resultant damage is greater than in the Salt River Valley with its greater rainfall and its longer period of humid weather during the hot summer months.

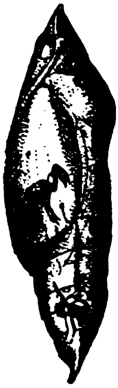

FIG. 10—*Pteromalus curymi*: Adults issuing from chrysalis of alfalfa caterpillar. Enlarged about three diameters.

CONDITIONS AFFECTING INJURY.

This insect is kept in control to a considerable extent by its natural enemies, such as insect parasites and diseases, and it is only upon the occurrence of conditions unfavorable to the development of these enemies that serious outbreaks occur. The seriousness of the damage often depends upon the farming methods used by the individual whose fields are attacked or upon certain contributory conditions, such as character of soil, quantity of water for irrigation, and location of land. The former cause is one that the individual may remedy by changing his methods, while the latter conditions may be alleviated by proper handling of the particular farm involved.

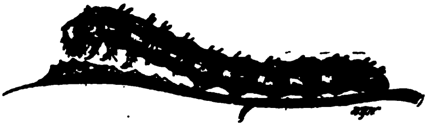

FIG. 11.—Bollworm (*Chloridea obsoleta*), an enemy of the alfalfa caterpillar. Twice natural size.

The damage in some alfalfa fields apparently is often correlated with the condition of the soil. A field seriously damaged often reveals a poor soil—at least a soil not well adapted to alfalfa culture, and consequently producing a crop that grows but slowly. Of course, not all of the fields damaged are of poor soil; some of the very best alfalfa fields are sometimes seriously ravaged, but in these cases this often is attributable to other factors. Sandy loams or light soils are the best for alfalfa production, and consequently are the least damaged, owing to the fact that alfalfa, growing rapidly, is able to recover from insect attacks and be ready for harvest before any damage has been done. A heavy soil can be improved and the growth of the alfalfa increased by deep plowing and thorough preparation of the seed bed at time of seeding, and afterwards by renovating the alfalfa several times a year, either by disking or by the use of an alfalfa renovator. Such a procedure in irrigated regions will make the soil take water more readily, and thus plant growth will be stimulated.

The progressive grower who uses up-to-date and proper cultural methods is unfortunate indeed when his alfalfa fields are just across the fence from fields that are run down, and, hence, are breeders of insects. No matter how strenuous his efforts, some damage may be done to his crop owing to infestation of his fields from the butterflies supplied by his neighbor's neglected field. Nevertheless enough may be accomplished through his own efforts to repay him many times.

Again, the amount of water applied is often insufficient, sometimes because of neglect on the part of the rancher, and sometimes because of scarcity of supply. The former case is under the rancher's control; he should use care in applying the water and should eliminate waste. Sufficient water should be used to provide for the prompt development of the alfalfa crop, for in this way the grower can harvest his crop before the caterpillars have effected much damage.

THE CONTROL OF THE ALFALFA CATERPILLAR.

DOMESTIC FOWLS.

Both chickens and turkeys feed quite greedily upon the young worms. Where an alfalfa field adjoins a home lot, and chickens have access to the alfalfa field, there are rarely any worms present. When available, a large flock of turkeys, herded by cheap Mexican boy labor in alfalfa before it gets very high, will almost totally reduce an outbreak. Turkeys and chickens are not always available, however, and thus the alfalfa grower must usually adopt other and more generally available methods.

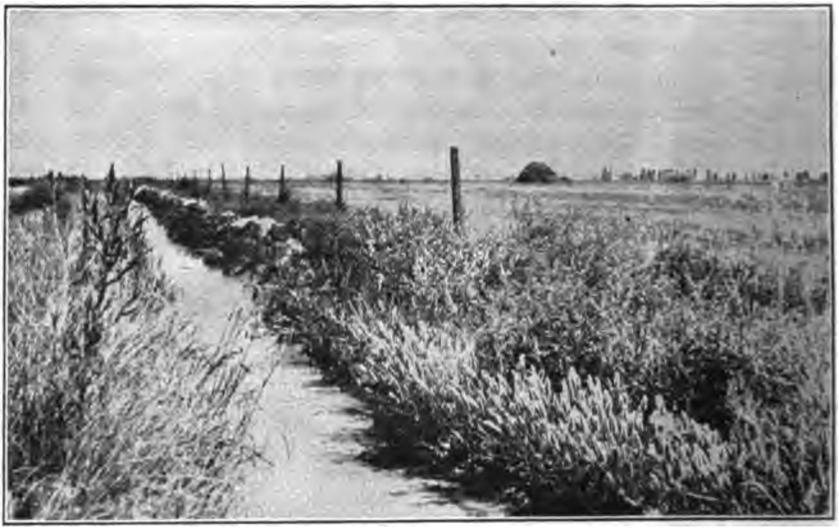

FIG. 12.—Fence row and ditch bank showing neglected growth of alfalfa and grass which offers protection and hibernating quarters for the alfalfa caterpillar and other insect pests.

IRRIGATION AS A FACTOR IN CONTROL.

As has been stated in a previous paragraph, moisture is conducive to the development of the disease which plays an important part in the control of this insect. Therefore, if a rancher can supply water or moisture artificially in a damaged alfalfa field where many larvæ are present, the worms often become diseased. This method is indeed very successful in irrigated regions. If a heavy irrigation is given the field just at the time when the worms are beginning to appear in numbers, this will supply the necessary moisture for the development of the disease and the worms soon will die. In order that a rancher may take advantage of this, it is necessary that he have water available at call, which is not the case in all irrigated regions where water is often distributed in turn. In cases where water can be secured on short notice or when the time for irrigation corresponds with the occurrence of an outbreak, the water can be utilized and the worms often killed without further trouble.

PASTURING VERSUS HAYING.

Alfalfa fields that are pastured are never troubled as much by the alfalfa caterpillar as are haying fields. This is due partly to the fact that the number of eggs deposited is greatly reduced and also to the fact that many of the eggs and small larvæ are destroyed by the grazing of the stock. The most important factor, however, is that the disease previously mentioned, which is common to many kinds of caterpillars, is more prevalent on pastured ranches than on hay ranches. The prevalence of the disease in such fields possibly is due to the fact that usually a few days after stock animals are admitted the alfalfa becomes trampled. The ground and the alfalfa are very moist, there being more or less dew every morning, and droppings from the cattle bring about a foul condition in the field, thus assisting in the retention of moisture, which, in turn, is conducive to the development of the disease.

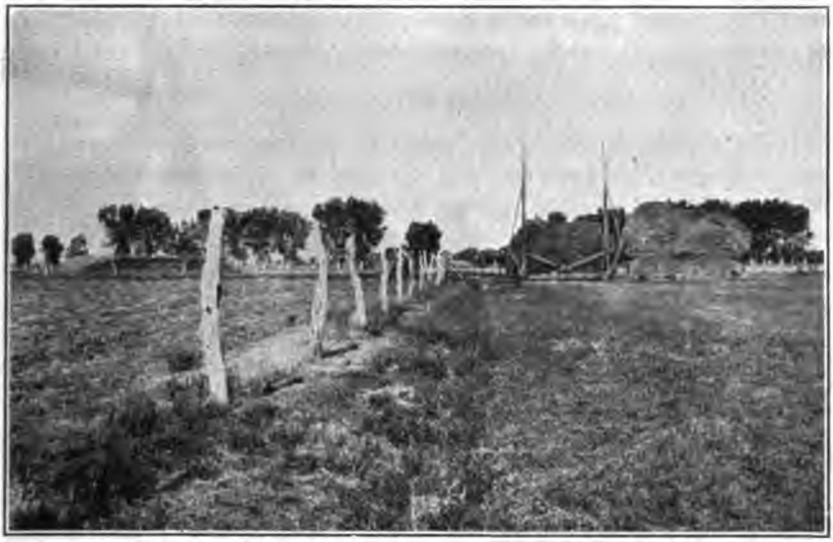

FIG. 13.—Fence row bordering alfalfa field, showing clean cutting, which helps to reduce the alfalfa caterpillar as well as other insect pests.

If fields can be systematically and carefully pastured, damage from the caterpillar will be kept at a minimum. Cattle should never be allowed on a field when wet nor for a longer period than from 24 to 35 days, and disking or renovating should always follow so as to loosen the soil and place it in a receptive condition for future irrigation. Experienced ranchers know the necessity for care in preventing bloating and also know that where labor conditions are properly adjusted the soiling of alfalfa can be carried on more profitably than pasturing, yet when caterpillars are numerous, these may be destroyed by pasturing.

It is on areas from which successive crops of hay are taken that the height of the damage by the alfalfa caterpillar is reached. In such fields the conditions for the development of the species are as nearly ideal as possible and here the worms are ordinarily unmolested in their feeding and growth. The period elapsing from the time when one crop is cut until another is ready for harvesting so nearly coincides with the length of the period necessary for the development of any one generation of the butterfly that the cutting of the hay, as ordinarily carried on, does not reduce their numbers or disturb their work, since the worm will likely be in the advanced stage, or, perhaps, have passed into the pupal stage before the crop is cut.

CLOSE CUTTING AND CLEAN CUTTING.

In harvesting the hay crop, ranchers usually have to depend upon labor that, while often the best obtainable, is not by any means of the best class, and thus cutting is often done in a careless manner, stubble is left high and ragged, bunches of hay are left uncut at turning rows or on borders, ditch banks and fence rows are rarely or never cut, and the field presents the spectacle shown in figure 12. Any caterpillars that may still be present have thus a considerable amount of alfalfa upon which to feed and develop, so that the butterflies from these are ready for the next crop. Such places also afford bloom which attracts adult butterflies from other fields, and these lay eggs on the new alfalfa that soon springs up. If such neglected fields are treated as is the one shown in figure 13, there will be no food to enable any remaining caterpillars to complete their development; besides this, there will be no protection for them from an early irrigation or the rays of the hot sun, either one of which will kill them. Heat of the midday sun, accompanied by prompt irrigation immediately following such clean cutting, nearly always results in killing the larvæ, especially in the warm Southwest. This is such an important item that one should not hesitate to go to the necessary expense in order to secure such a condition of cleanliness.

VALUE OF DISKING AND RENOVATION.

It has been suggested before that alfalfa fields should be disked or renovated annually or oftener in order to keep the sod in good loose condition, so that it will take water readily and be aerated, and also to kill the weeds. If teams are available or if a tractor can be secured, the best procedure is to renovate several times or at least twice a year. The usual method is to renovate once, and this during the winter. Now, if the alfalfa can be renovated in August, immediately after the third crop is removed, not only will the ground be placed in an excellent condition and weeds killed, but any larvæ or pupæ on the ground will be killed and future crops protected from damage. Some ranchers are observing this practice, and claim excellent results for it, and a few renovate even oftener. Leaving the matter of insects entirely out of consideration, enough benefit is derived from renovation to pay many times for the cost of the work.

ROLLING AND BRUSH DRAGGING.

At the time a field is being damaged by the worms, the hay that remains undestroyed can be cut and then either a brush drag or a roller run over the ground, by which a great many of the larvæ may be destroyed.

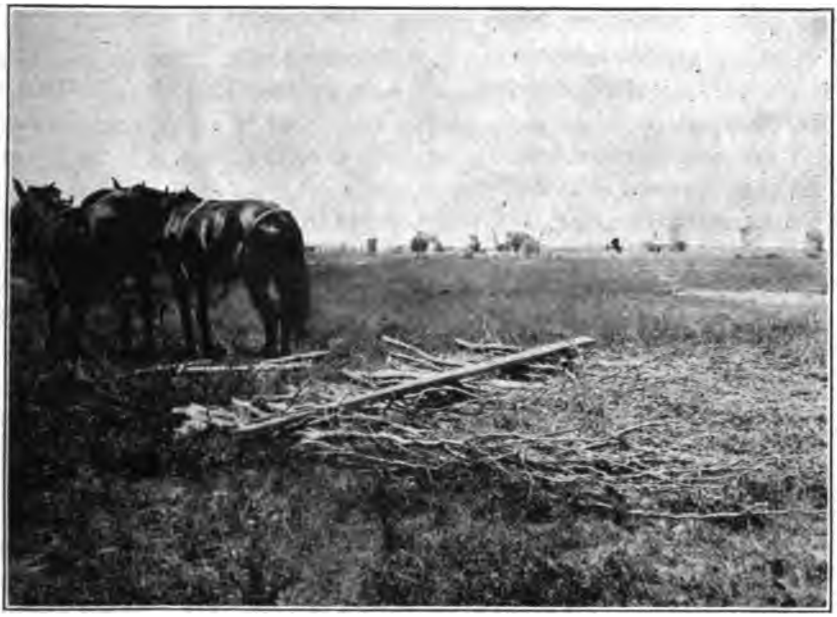

FIG. 14.—Brush drag used in the destruction of the alfalfa caterpillar in new growing alfalfa.

A good brush drag and one that is well adapted to dragging alfalfa is shown in figure 14. The plan for constructing this, as given by Mr. E. S. G. Titus,[1] is as follows:

> [The drag] is made by laying the butts of rather short brush, 5 or 6 feet long, in a row on a plank 12 or 14 feet long, then another row should be laid upon the first, consisting of longer brush, with the butts trimmed a little further back so that you will have in effect two brush harrows, one following the other. Another plank should then be laid on the brush butts and bolted to the under plank. In weighting this harrow, lay an ordinary tooth harrow, with the teeth down, directly on the brush drag. This makes a very even weight, at the same time it is so flexible that the drag will work its way down into the small depressions as well as over the larger elevation of the field.

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[1] Titus, E. G. The alfalfa leaf-weevil. Utah Agr. Coll. Exp. Sta. Bul. 110. 1910.

SUMMARY OF CONTROL MEASURES.

Keep the ranch in the best possible cultural condition. Irrigate it often and thoroughly, either immediately before cutting or as soon after cutting as the crop of hay can be removed from the ground.

Renovate every winter and during the month of August, or even oftener if possible, by the use of a good type of alfalfa renovator, thus disturbing any pupæ that may be present and putting the land and alfalfa in condition for good growth of succeeding crops.

Cut the alfalfa close to the ground and clean, especially along the ditch banks, borders, and turning rows, as well as in the main part of the field.

Cut the alfalfa earlier than is the general rule. The proper time is when it is just coming in bloom or is one-tenth in bloom. Watch for caterpillars in the early spring crop, and if many are observed and are about grown, cut the hay a few days before it is in bloom, and thus save the next and future crops.

A minimum amount of damage occurs in fields that are systematically pastured all or a part of the time.

Excessive moisture is conducive to a diseased condition of the larvæ, and this one fact is of the greatest importance in control. When worms begin to appear in numbers, if possible supply this moisture by irrigation and thus assist nature to destroy the worms.

A field should never be abandoned because the caterpillars threaten the destruction of a crop of alfalfa before the hay can possibly mature. Mow it at once, cutting it low and clean, thus saving part of the present crop, and in so doing starve this generation of worms and allow the heat of the sun to kill a great many. Follow this by disking and then by either rolling or brush dragging, and a great majority of any remaining larvæ will be killed. The ground should then be thoroughly irrigated, and by these efforts the future crop will be assured.

Turkeys and chickens when allowed the run of a field will keep the numbers of the caterpillars at a minimum.

The protection of toads should be encouraged, as they eat many of these insects as well as other injurious forms.

It has been noted that carrying out only a part of these recommendations will not at all times save the crop. The best results come when one is thorough in his methods.

Cooperation among all growers is necessary to suppress completely an insect attack. An occasional outbreak has been known to occur upon a farm or ranch that is under the best possible condition of crop culture, but in each case it was noted that the careless methods of a neighbor were responsible for the infestation.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

A1.9:1095

FARMERS' BULLETIN 1095
UNITED STATES DEPARTMENT OF AGRICULTURE

Beet Top Silage and Other By-products of the Sugar Beet

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1819

THIS BULLETIN discusses the more profitable methods of utilizing the tops and other by-products of the sugar beet.

In the Intermountain States there is a shortage of hay and other forage, and the siloing of beet tops will aid in meeting this shortage. The value of sugar-beet tops, molasses, and pulp is becoming more and more generally recognized by feeders of live stock. This bulletin illustrates good methods of constructing pit silos and gathering and siloing the tops. It also makes important suggestions in regard to feeding the silage, molasses, and pulp, based largely upon reports of beet growers and stock feeders.

Most beet growers estimate that beet-top silage has a value about one-third to one-half that of alfalfa hay. The silage is well suited for the dairyman or for the feeder of beef cattle and sheep. When beet-top silage is fed for the production of beef or mutton, the hay requirements may be reduced 50 per cent; furthermore, the warm, succulent silage seems to stimulate the appetite of the animals, causing them to consume and utilize larger quantities of feed.

Beet pulp and molasses, by-products which have an established value with stock feeders, should be fed with a moderate allowance of hay or other feed in order to make a balanced ration. At the present price of beet molasses many feeders are finding a mixture of molasses with hay or with pulp to be profitable. This furnishes variety and stimulates appetite when fed in regulated quantities.

In feeding beet-top silage, about 30 pounds per 1,000 pounds weight for cattle and 3 pounds per head for sheep each day seem to be most satisfactory.

Animals not accustomed to beet-top silage should be given a small quantity at first and the feedings gradually increased until the normal ration is reached.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C.   December, 1919

BEET-TOP SILAGE AND OTHER BY-PRODUCTS OF THE SUGAR BEET.

By James W. Jones,
Agriculturist, Sugar-Plant Investigations.

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THE BEET-SUGAR INDUSTRY produces five by-products that enter into stock feeding in an important way. These are beet tops (leaves and crowns), pulp, molasses, seed beets, and beet tails.

BEET TOPS.

Beets are bought by the sugar company from the grower, primarily for their sugar content. In the crown of the beet certain salts accumulate that interfere with the recovery of sugar from the juices, and therefore the grower discards that portion of the beet to which the leaves are attached. These tops are left lying on the ground in the field when the beets are harvested.

BEET PULP.

After the beet is sliced in the factory the resulting product, commonly called cossettes, is processed through batteries and the saccharine matter is extracted. The remaining fibrous mass is called pulp.

BEET MOLASSES.

In the process of recovering crystallized sugar from the saccharine juices the negative elements that are found in the beet juices prevent a complete recovery of crystallized sugar, and the residue from this process in the factory is called molasses.

SEED BEETS.

A considerable quantity of beet seed is grown in the intermountain country. The seed is usually harvested late in July and August. The seed beets that remain in the ground after the seed stalks are harvested, weighing from 6 to 10 tons per acre, carry a sugar content ranging from 5 to 8 per cent or more.

BEET TAILS.

Handling beets on and off the wagons and at the dumps and in the storage bins causes the " tails " of beets to break off. These tails accumulate usually in catch basins and traps in the flumes at the beet end of the factory. From 2 to 4 tons a day of these accumulate at each factory. In many of them this by-product necessitates a labor expense to cart it away to the refuse heap.

RATIO OF TOPS TO ROOTS.

The grower who maintains soil fertility that is reasonably rich in available nitrogen will often have as much as 8 tons of tops per acre lying on the field after the beets have been marketed. Other growers will have not more than half that quantity. Many field tests show that when the beet is ready to be harvested and before killing frosts occur, if the topped beets are weighed separately from the tops the weights are about equal. As soon as the tops are cut off, they begin to evaporate moisture, which changes the weight ratio. The beets when left exposed to the sun and wind also evaporate moisture, but the shrinkage in weight is not so rapid as with the tops. When the tops are put into small piles and allowed to remain on the field four or five days, they will weigh about half as much as the marketed beets. There is always some waste in gathering the tops. Sometimes the tops that are gathered from the field will weigh not more than 40 per cent and in other instances they will be in excess of 60 per cent of the weight of the marketed beets. On good soil, where the tops are gathered without undue loss, it is reasonably safe to conclude that about two-thirds of the crop is marketed to the factory.

The studies reported upon in these pages have been made mainly in the States of Idaho and Utah. A conservative estimate indicates that more than 400,000 tons of tops will be produced in these two States from the 1919 crop of beets. At the prevailing price of hay and other feeds, beet-top silage will be worth $8 or more a ton.

OBSERVATIONS OF A BEET GROWER.

One extensive beet grower and feeder makes the following deductions:

> One acre of beets produces 3½ tons of cured beet-top silage, which, when fed at the rate of 35 pounds of silage per day per steer, will carry two 1,000-pound steers for a 100-day feeding period.

The acre of beets will also produce 4 tons of green beet pulp, which, when fed to 1,000-pound steers at the rate of 40 pounds per steer per day, will carry two steers for a 100-day period.

The acre of beets will also produce about half a ton of molasses, which, when fed to 1,000-pound steers at the rate of 5 pounds per steer per day, together with the cured silage and pulp mentioned above, will carry two steers for a 100-day feeding period. This ration, together with a moderate amount of alfalfa hay, will fatten and finish beef profitably. This contemplates a feeding capacity at the rate of two steers for a 100-day period for each acre of beets. The planted beet area for the States of Utah and Idaho approximated 150,000 acres for the 1919 season.

These figures are of especial economic interest when it is known that a serious hay shortage occurred in the 1919 crop in both States.

SAVING THE HAY.

After compiling the data gathered from large numbers of feeders throughout the intermountain country it is found that beet tops when properly made into silage and then feed with alfalfa hay will reduce the hay requirements by approximately one-half. Therefore, beet-top silage will greatly aid in meeting the hay shortage. Beef and mutton gains may be had on a normal basis when the change is substituted. The beef feeder has found that feeding 30 pounds of beet-top silage to a 1,000-pound steer will reduce the hay requirements from 30 pounds a day to 15 pounds a day. Comparable results are had when this ration is applied to the dairy herd. The feeder of sheep has found that a daily ration of 3 pounds of beet-top silage per head will reduce the hay requirements by one-half. (Fig. 1.)

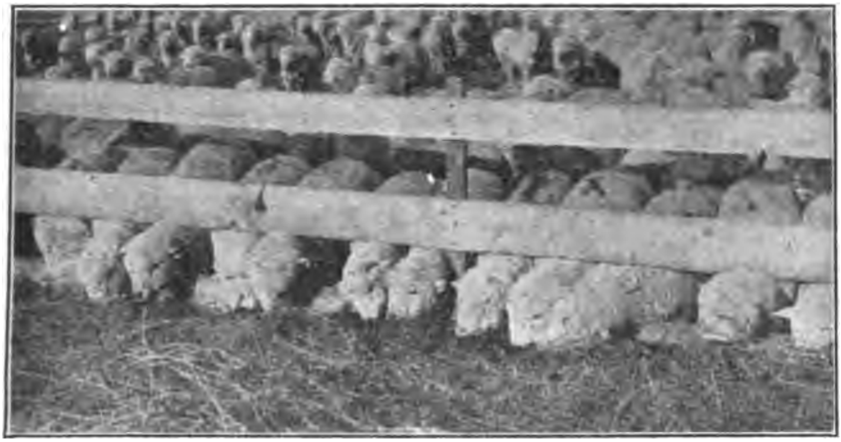

FIG. 1.—Lambs being finished for the market on a daily ration consisting of 3 pounds of beet-top silage and 1½ pounds of alfalfa hay per head.

Stock cattle are commonly carried through the winter by feeding 20 to 25 pounds a day of beet-top silage with oat straw. These stock are found to be in better condition when spring arrives than when fed alfalfa hay only, which is also a common practice in carrying stock cattle through the winter.

With a serious hay shortage confronting the intermountain districts, it is of importance that all available feeds be utilized in the most economical way.

DIFFERENT PRACTICES.

GRAZING THE TOPS.

A practice that has been most widely followed has been to turn cattle or sheep upon the fields in the fall, as soon as the beets have been removed, as shown in figure 2. The stock are usually fed upon the fields for only a limited time each day, thus regulating the quantity that they are allowed to consume. Because the tops are of an appetizing character, stock will overfeed unless restricted. The salts in the beet crowns are cathartic and tend to scour the animal; hence bad results may follow if the quantity of beet tops consumed daily is not restricted. Sometimes bloating will also cause loss. However, for finishing lambs for market and for carrying stock cattle through, the grazing of beet tops off the field when fed in a regulated way yields excellent results. It is estimated that 1 acre of beet tops will graze one steer for 100 days. Very profitable mutton gains are also often attained by feeding in this manner. This practice involves the minimum amount of labor. When stock are pastured upon the fields, the animal fertilizer is distributed without further labor. Occasionally, lambs and cattle

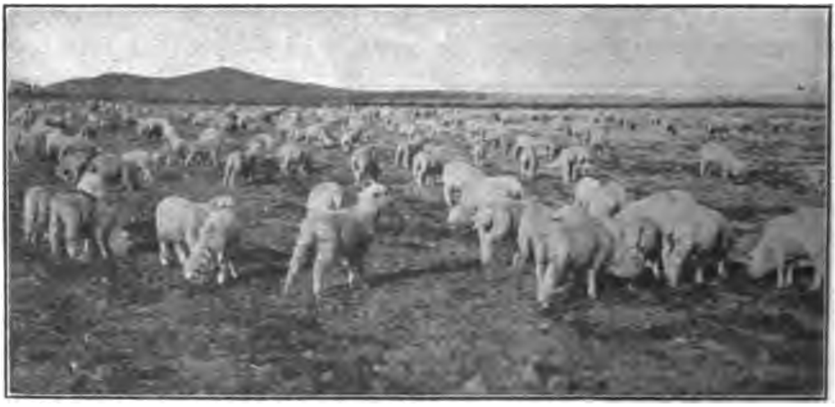

FIG. 2.—Lambs grazing beet tops on a field after the beets are harvested. This method of utilizing the tops involves the least labor. When fed with discretion, lambs will make excellent gains when turned in on the beet fields after harvest. Delay in grazing the tops may also put off fall plowing until freezing weather. Fall plowing is important for the beet crop.

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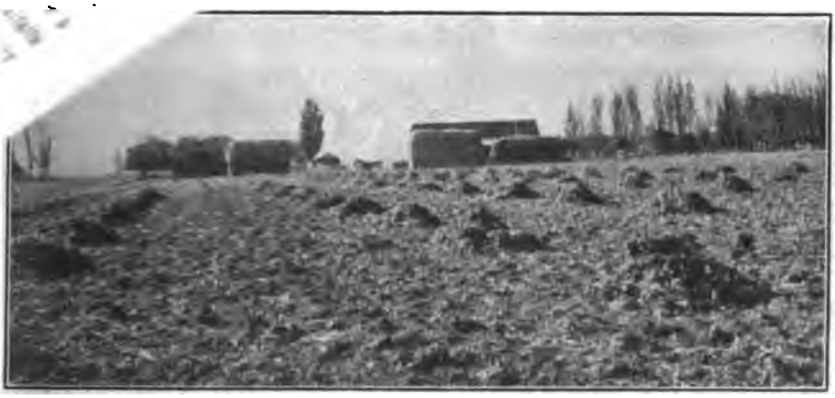

FIG. 3.—Beet tops should be put into small piles soon after the beets are topped. When left in piles of approximately 100 pounds, there is little danger of heating. When put into piles, less dirt is gathered and there is less loss by trampling while the beets are being hauled from the field. When piled as above illustrated, the tops may be left two or three weeks before they are put into the silo. If left for a longer period, they will cure and may be safely mixed with straw and stacked as hay is stacked.

Many beet growers conclude that beet tops are worth from $10 to $12 an acre when grazed as just described. Where the beet grower does not have stock to utilize the pasturage, it is a common practice to sell the tops in the fields to stockmen at from $3 to $6 per acre. When feed is scarce and high priced this pasturage is sometimes sold at higher prices. Outside stockmen have the expense of bringing their stock to the fields, caring for them, and taking them away. Therefore, they do not pay as much for the tops as it is possible for the beet grower to realize by feeding them to his own stock.

CURING AND STACKING.

Some growers find it profitable to cure the tops and stack them after the manner that hay is cured and stacked and then feed them throughout the winter. When it is difficult to evaporate and thus properly "cure out" the tops, straw is intermixed while they are being stacked. This plan contemplates gathering the tops rather promptly after topping and putting them into small piles, as shown in figure 3. A little later they are hauled to the feed yards, where they are stacked. The equipment for loading and hauling the tops is shown in figure 4. Many growers feel that it is more profitable to cure and stack the tops so that they can be fed throughout the winter than to pasture them in the field, as previously described.

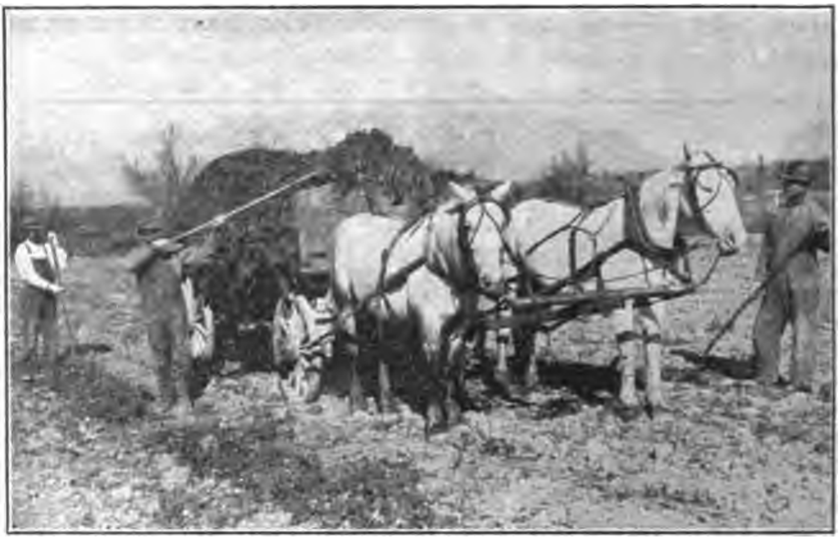

FIG. 4.—Gathering beet tops in the field. The wagon with a beet rack is a convenient equipment. Where lack of help prevents hauling the tops from the field soon after the beets are topped, the tops should be put into piles of about 100 pounds each, where they will keep for two or three weeks without seriously deteriorating before they are put into the silo. If left lying loose upon the ground, there will be too much evaporation of moisture and much wastage.

SILOING BEET TOPS.

The most profitable practice that has been found for the average beet grower is to silo the tops. This practice is not new or untried. Silage is a succulent feed which, when fed with alfalfa or other hay, has a supplemental value greater than is commonly shown in a study of tables that are compiled from laboratory analyses indicating the comparative food values of different feeds.

The succulent silage stimulates the appetite of the animals and causes them to eat a larger volume of feed than they would consume otherwise. It also furnishes a more nearly balanced ration when fed with hay of alfalfa or some other legume and supplemented with grain.

The accumulated salts found in the crown of the beet constitute the chief reason for cutting it off and leaving it on the field instead of shipping it to the factory. They seriously interfere with crystallization in the recovery of sugar. As heretofore stated, these salts also have a cathartic property and may scour the animal; but the cathartic properties of beet tops are largely corrected in the fermenting process in the silo. A study of sheep or cattle in the feed lot where beet-top silage is properly fed shows no unusual number of cases of scouring. This indicates that with silage a more profitable use of the food constituents is being made by the animal. After a careful study of this feature the conclusion is reached that profitable beef or mutton gains may be made, even at the finishing stage, where good beet-top silage is a generous part of the ration, and this conclusion is borne out in practice.

Mr. E. R. Brisbin, with a packing company of Butte, Mont., reports that the shipping shrinkage on cattle that are fed and finished where beet-top silage is a generous part of the ration is not greater than the shrinkage commonly found in cattle that are fed and finished with alfalfa, grain, and concentrates. He also states that the dressing percentage of cattle that are largely fed and finished with alfalfa hay and beet-top silage compares favorably with that of the best cattle that they use.

These statements were made after an experience during the feeding period of 1918–19. This period involved the feeding and finishing of 2,250 head of steers fed by 32 different farmers growing sugar beets in the upper Snake River valley of Idaho, where beet-top silage was extensively used.

These cattle were delivered to the beet growers from the range in November, 1918. Marketing began on February 10 and was concluded about April 1, 1919. The 2,250 steers showed an average gain of 170 pounds per head. The average spread in the price of the feeders and the finished cattle was 2½ cents per pound. The beet growers in some instances pastured the cattle upon their different fields for a time after receiving them, but they were fed and finished mainly with alfalfa hay, beet-top silage, and beet pulp. The most satisfactory practice was to start with pulp and hay and later add the silage, finishing with about 30 to 35 pounds of silage and 15 to 20 pounds of hay per day. Not many feeders used grain. Several used a light spreed of beet molasses upon the pulp or hay. After making deductions for the market price of hay and all other feeds and also for wages for the time spent in feeding, the 32 beet growers made a net profit of more than $40,000 in feeding this lot of steers. This did not credit the operation with the several thousand tons of manure which was later spread upon the beet fields, thus greatly aiding to maintain soil fertility.

John Stosich was one of the most successful of the 32 feeders. His 26 steers were delivered to him on November 22, 1918, at an average weight of 1,018 pounds. On March 11 they were weighed out at 1,265 pounds gross, showing a gain of 247 pounds per steer. During the first three weeks the steers were grazed on the fields, gleaning feed from along the fences, irrigation ditch banks, and the autumn growth on the grain and other fields that otherwise would have been waste. On December 15 they were started upon a light feed of hay and about 75 pounds of wet beet pulp per head each day. The pulp was gradually increased to 140 pounds. On February 1 beet-top silage was mixed with the hay and pulp. The pulp was gradually decreased, and finally the beet-top silage was entirely substituted for it, finishing the steers on 30 pounds of silage and less than 20 pounds of alfalfa hay daily. The steers produced 225 loads of manure, which Mr. Stosich spread upon 15 acres that were seeded to beets in April, 1919.

These results are mentioned in detail because they illustrate an entirely profitable method of marketing surplus hay with the beet tops and other farm-grown feeds. At the same time they produce a fertility that renders it possible to increase the beet tonnage and makes for more profitable farm crops.

Siloing and feeding the beet tops mixed with pulp, hay, and molasses were the incentives which started the beet growers in this particular district to feeding cattle. They would not have undertaken to do the feeding had it not been for the increased supply of feed they had secured as a result of siloing their beet tops. Their winter profits in the feeding operations handsomely supplemented their earnings from the growing of crops during the summer. They had no worry about marketing and delivering surplus hay. They were enabled to fertilize properly an increased acreage and to meet the perplexing problem of maintaining soil fertility. This procedure has stabilized the beet crop with these growers, and it has also greatly aided them in establishing a crop rotation, which is seriously needed in most beet-growing areas. Making better use of the beet tops will reduce the hay requirements and allow part of the alfalfa land to be plowed. More feeding means more manure available on the farm, while better fertilized soil allows other intensive crops to be grown profitably in rotation with beets, grain, and alfalfa. The procuring of the steers and the supervision of their feeding were done by an experienced feeder employed by a sugar company. The entire enterprise also had the assistance of the farm bureau and the extension division of the University of Idaho.

PROFITABLE GAINS.

A sugar company in Colorado owns and operates several thousand acres of land tributary to its sugar factories, feeding regularly several thousand head of cattle. One lot of 135 steers made an average gain of 2.3 pounds per head daily in a period of 115 days, counting the shrinkage in buying on the Denver market and on the outshipment to the Kansas City market. This company found the following ration per steer per day to be good: 25 pounds of beet-top silage, 60 pounds of beet pulp, 10 pounds of alfalfa hay, 4 pounds of beet molasses, and 3 pounds of cottonseed cake. Accurate records of the operations showed a labor cost of 70 cents per ton for hauling the tops and filling the silo. This company calculates that cured silage was produced at the rate of 35 per cent of the weight of the marketed beets and that a heavy crop of beets will yield from 5 to 6 tons of silage per acre of beets. A 10-ton crop of beets has yielded 3½ tons of cured silage per acre. In estimating siloing capacity (the earth-silo type) about 38 cubic feet for each ton of beet tops is calculated, allowing a settling of 12 inches for a well-packed silo 5 feet in depth. The following analysis of beet-top silage, comparing it with the standard analysis of corn silage, was made at the company's laboratory:

Comparative analyses of beet-top and corn ensilage.

Constituents.	Beet-top silage.[1]	Corn silage.[2]
Moisture	64.36	68.50
Ash[3]	9.25	1.51
Crude protein	2.87	3.12
Crude fat	.44	.80
Crude fiber	5.46	6.53
Nitrogen-free extract	17.62	20.54

[1] It is possible that silage produced from beet tops grown in other localities might show a higher or a lower feeding value.

[2] The analysis here given for corn silage is considerably higher than the generally accepted standard analysis for this product.

[3] Dirt gathered with the tops makes a high ash content.

A VALUE NEARLY EQUAL TO ALFALFA HAY.

A firm of extensive feeders in the northern Colorado district after an experience of several years says—

> We believe 1 ton of tops properly siloed is worth almost, if not altogether, as much as a ton of alfalfa hay for feeding to cattle. Any farmer, regardless of the size of his beet field, can cheaply make a pit, save all of his tops, and feed them at any time, as there is no limit to the time that they will keep. We have been very successful in getting good gains on our cattle since we started feeding them in this way.

COLLATERAL VALUES.

The average beet grower concludes that 2 tons of good beet-top silage is worth 1 ton of good alfalfa hay. Very few men who have fed the silage think that it has a value less than 50 per cent of the value of hay. Those who consider the value as great as the estimate above quoted probably reach conclusions that are not entirely based upon the intrinsic value of the silage. There are two collateral values in the silage that are not shown in the laboratory analyses, namely, (1) the succulent character of the feed, which stimulates an appetite in the animals and causes them to consume greater quantities than where dry, cured feeds only are used; and (2) the beet-top silage when fed with alfalfa hay helps to balance the ration and causes the animal to utilize better all the feed consumed.

EXTENSIVE FEEDING TESTS.

A firm of extensive beet growers in Idaho feeds several thousand sheep and grows from 75 to 150 acres of beets each year. For two successive seasons they have made and fed about 500 tons of beet-top silage. They recently made the following statement:

> We did not keep check on all of our feeding all winter, but we weighed the feed to some of the herds of sheep long enough to satisfy ourselves that a ton of beet-top silage is worth as much as a ton of hay. We have also proved to our own satisfaction that beet-top silage for fattening sheep and cattle is cheaper and will fatten quicker than grain or corn. We think that the tops, if gathered immediately after being cut off, will weigh half as much as the beets.

It should be noted that the above statement is based upon observation rather than upon actual test by weight, but it shows what value the growers place upon beet-top silage used as a stock feed. The growers referred to above find that by feeding 3 pounds of beet-top silage per head per day they can reduce the hay requirements for sheep more than half.

After an experience of two seasons with beet-top silage a successful Idaho feeder offers the following suggestions:

> The beets should be topped from windrows or piles and the tops gathered immediately, free from dirt, and placed in small piles or hauled directly to the silo. Pack firmly in the silo. If the silo is located on sandy soil, build a concrete retaining wall for each side. It is important to eliminate the dirt. Three pounds of beet-top silage per head per day were fed for a period of 40 days to 800 head of sheep, about one-half ewes and one-half lambs, which made a gain of 4 pounds per head more than sheep of like quality that were fed entirely on beet pulp and hay. The silage comes out warm. even in midwinter, and is greatly relished by the sheep.

This feeder made 125 tons of silage from 25 acres of beets. It cost him about $1 per ton to gather and silo the tops.

UNANIMOUS APPROVAL.

As against the very few adverse experiences which have been reported, the following statement taken from the Farm Bureau News, the official organ of the Sevier County (Utah) Farm Bureau, is offered:

> Without an exception, every man who siloed beet tops last year reports excellent results and savings from the feed that it furnished. Most of the farmers reporting rate the value of the silage at about 2 tons of silage equal to 1 ton of the best alfalfa hay. One or two men say that it is nearly equal in feeding value to alfalfa hay.

A GOOD DAIRY FEED.

In the Weber County (Utah) Farm Bureau News, Mr. James G. Widdison, jr., says:

> About the first of January I opened the silo and found that the tops had kept perfectly. The cows relished them as much as they did the fresh tops, and they did much better when fed only a limited amount than when allowed to run at will on the tops in the field. The milk produced was also of good quality and had no disagreeable flavor that is sometimes complained of when cows are fed beet pulp. I have no accurate information as to feed value in pounds, but would say that a ton a week fed to six cows would enable them to do nicely on the hay that one cow would eat if fed hay only. I find it also a convenient and valuable feed for pigs. I have decided that beet-top silage shall have a place in my winter feed from now on, even though its care requires a good deal of time in our busiest season, which many farmers complain of.

ADVERSE EXPERIENCES.

FEEDING AGED EWES.

One man had bad results in feeding beet-top silage to aged ewes. Samples were taken from the silo. The analyses indicated that the silage was normal. It is likely that the chief cause of trouble was the feeding to weak ewes of too much of the succulent silage at the outset. In most instances, those who use aged ewes find that silage will cause them to produce more milk for their lambs than they otherwise would, which allows them better to sustain their usual large percentage of twin lambs. Two instances were reported where the milk flow was excessive when beet-top silage was fed to aged ewes, and the udders became swollen and feverish and gave trouble in this respect. Beet-top silage should always be fed lightly at the start.

FEEDING STEERS.

In another instance an extensive feeder lost several head of steers while feeding beet-top silage. The tops were gathered carefully from a sandy soil. The silo was located on a sandy spot. It is difficult to gather tops from a sandy field and then silo in sandy earth with sandy side walls in a pit silo without having an excessive proportion of sand in the silage. In some instances as much at 5 per cent of the net weight of the silage was found to be sand and dirt. Compacting in the stomach of the animal is almost sure to follow when there is much sand or dirt in the silage.

BEWARE OF MOLDY SILAGE.

Steers have died as a result of improperly feeding hay and grain. It is important that the moldy silage that is found on and near the surface or sides of the silo be carefully removed and destroyed. Moldy silage is even more dangerous than moldy straw or moldy hay. These often cause loss with animals.

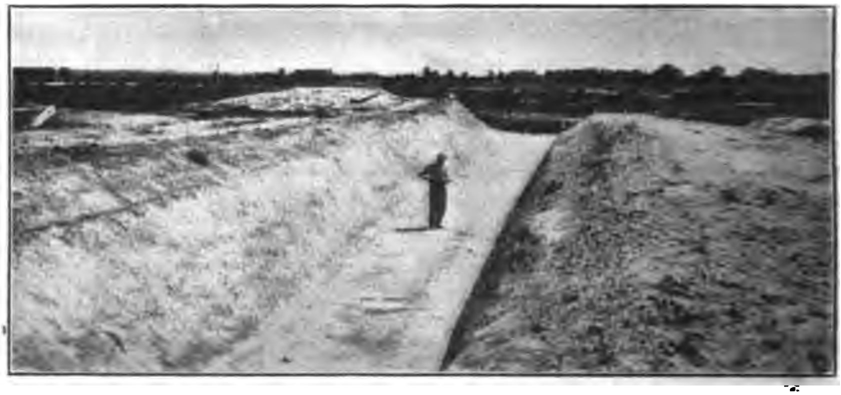

FIG. 5.—A long, deep type of earth silo, 10 feet wide at the bottom. The location is on a well-drained hillside convenient to the feeding yards. The earth is a stiff clay, and the sides remain solid and firm. On sandy soil it is recommended that concrete retaining walls be put in, to prevent the soil from getting mixed with the silage.

In a few instances horses were allowed to get to the beet-top silo and gorge themselves. Even good silage is not recommended for horses, pigs, or calves. Moldy silage is almost sure to cause trouble if fed to any kind of stock. The total number of bad results reported from the feeding of beet-top silage is very small.

THE BEST PRACTICES

PILING THE TOPS.

It is important that the tops and crowns be gathered free from dirt. With an ordinary fork the dirt can be readily shaken off the tops if they are gathered while still fresh. When placed in small piles of approximately 100 pounds to the pile, as shown in figure 3, there will not be a sufficient quantity to heat. In these small piles the loss through evaporation is not great, even though the piles are allowed to remain on the fields for two weeks before they are hauled to the silo. Collecting in small piles facilitates driving teams with wagons while gathering the beets from the fields without trampling the tops. A flat-top rack on a low-wheeled wagon or an ordinary dump type of beet rack is convenient for hauling the tops from the field to the silo. When such a pit silo as is shown in figures 5 and 6 is used the team with the loaded wagon is driven through the silo and the tops are dumped and then scattered and packed in the silo, as seen in figure 6. There are two disadvantages in this practice. There is a tendency to dump the tops too much into piles instead of spreading, and the packing is liable to be irregular, and all the dirt that is thrown on the wagon in gathering the tops is dumped into the silo. If the wagon is driven alongside the silo and the tops forked off much less dirt will get into the silo. It is important to have the tops spread evenly in the silo; otherwise the settling will be irregular.

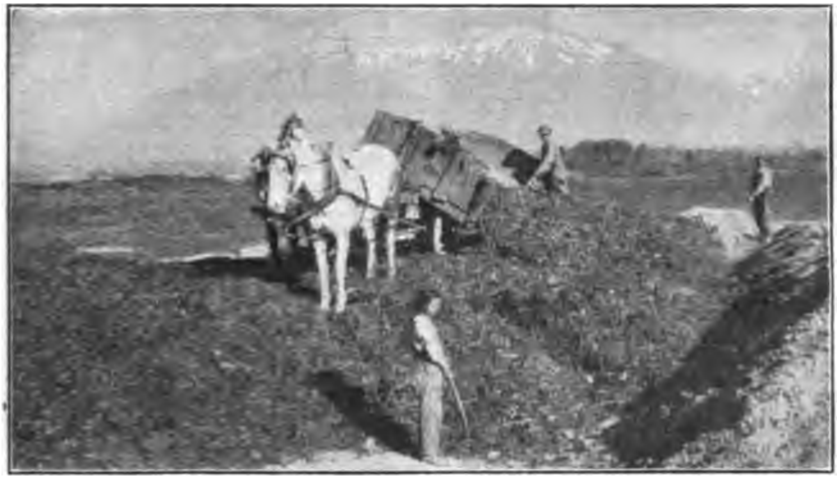

FIG. 6.—The natural earth or pit silo is constructed with sloping ends, so that the team and wagon may be driven over the mass of tops. Dumping the tops as here illustrated has two disadvantages, however. The tops are usually not well spread, and therefore the mass settles unevenly. All the dirt that may be gathered with the tops is also dumped into the silo, whereas if the tops were forked from the wagon alongside and then spread there would be less dirt in the silage. At the far corner is shown an illustration of the method of placing straw at the edge of the mass of tops before the earth is drawn against the sides. It is important to keep the dirt from getting mixed with the silage.

THE ADDITION OF SALT AND STRAW.

Five pounds of salt spread with each ton of green tops improves the quality of the silage. Straw may be spread with alternate layers of beet tops, as shown in figure 7, provided the tops are put in while still fresh. Straw is not recommended where the tops have evaporated much moisture. Very much more thorough packing is required where straw is used.

TYPE OF SILO.

The concrete (fig. 8), stave, or other type of silo structure commonly built for making corn silage may be used for siloing beet tops. Where these structures are used, it will be best to run the tops through the usual cutting device, much as corn silage is treated. It is suggested that the tops be forked from the wagon to an open slatted table attached to the cutter, so that the dirt will sift through and not get into the silo. Because beet tops pack more solidly than chopped corn silage, the outthrust is greater and silos sometimes crack and leak when filled with beet tops. Sometimes the corn silo is not entirely filled and it is reasonably safe to finish filling the silo with beet tops, provided the structure is well built.

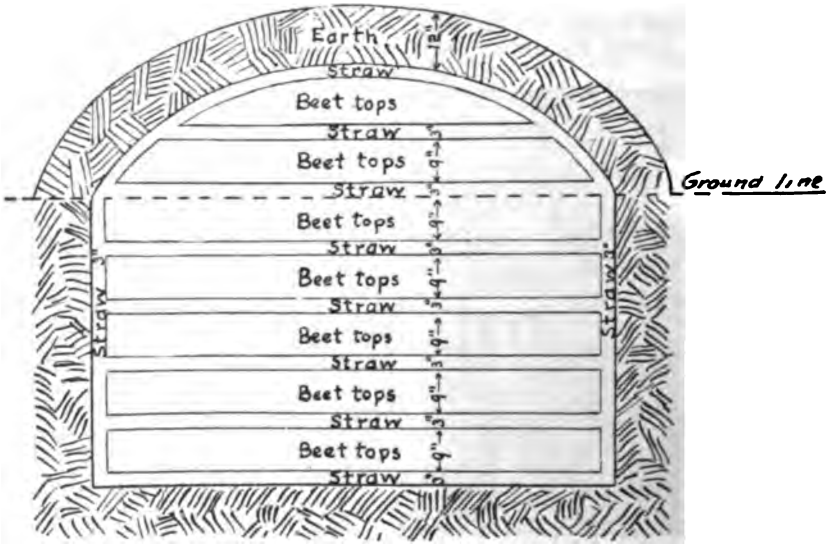

FIG. 7.—Sectional view of an earth silo. The quantity of silage may be increased by alternating layers of straw with beet tops. It is absolutely necessary that the tops be gathered while fresh, with an abundance of moisture to facilitate packing when straw is used. The use of straw requires about twice as much packing as otherwise would be necessary. It is imperative that all free air be excluded. Unless proper precautions are observed it is best not to alternate with layers of straw. It is always a good plan to put a layer of straw in the bottom, against the sides, and on the top, to aid in keeping dirt from the silage.

It is not necessary to erect an expensive perpendicular silo for beet tops. The horizontal type, using the excavated pit with earthen sides, as shown in figure 5, or concrete retaining-wall sides, as seen in figure 8, is less expensive and entirely efficient if care is used in filling. Figure 9 shows the process of excavating a pit silo.

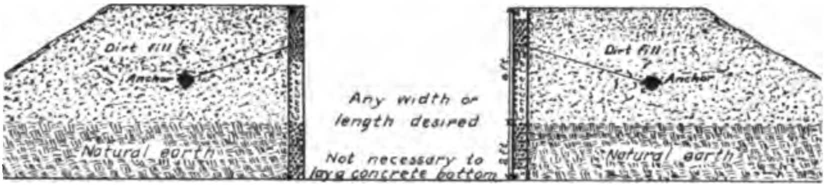
Dirt fill
Anchor
Natural earth
Any width or length desired
Not necessary to lay a concrete bottom
Dirt fill
Anchor
Natural earth

Fig. 8.—The horizontal concrete silo, illustrating a plan for a silo with concrete retaining walls built perpendicular and smooth. This facilitates solid packing at the edges and makes it possible to exclude the air. The wall is anchored at intervals to prevent its being pushed in when the heavily loaded wagon is driven over the dirt fill. Much less dirt goes into the silo when the tops are forked from the wagon into the silo. The width should be sufficient to allow driving the team and wagon through to pack the tops and also to load in taking out the silage. Good drainage is essential.

The dimensions of the pit silo may vary according to the quantity of material that is to be siloed. The construction shown in figure 9 is better than a square or a circular shape.

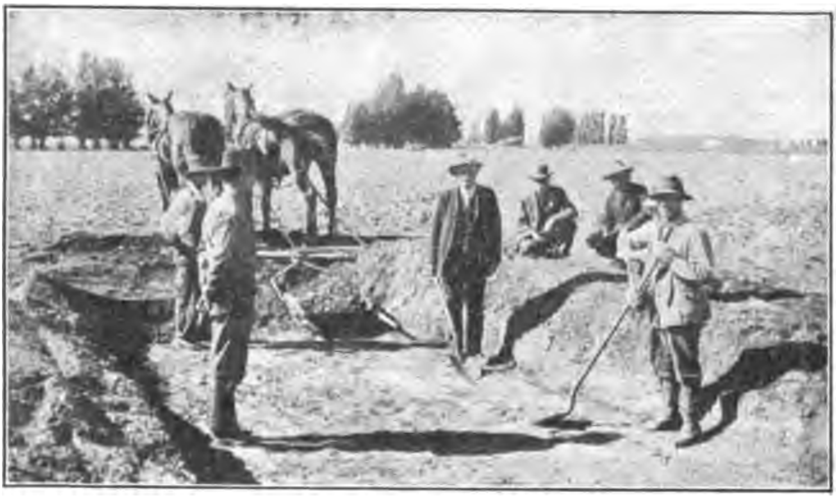

Fig. 9.—A county agricultural agent and a sugar-company agriculturist demonstrating the method of excavating for a beet-top silo. Most of the excavating can be done with a team and scraper. The sides may be shoveled by hand. The dimensions can vary according to the quantity of tops to be siloed.

When the tops are packed to a depth of 5 to 8 feet, the free air is better excluded and a better quality of silage is made.

A long deep pit, like the one shown in figure 5, is better than a broad shallow pit. Earth may be drawn against the sides and firmly packed where the tops are heaped above the surface earth or retaining wall.

Where the water table comes near the surface, excellent silage may be made by stacking the tops entirely aboveground, as seen in figure 10. The wastage, however, is greater. In any event, the tops should have sufficient moisture in them to facilitate compression in packing the mass, giving the silage the solid appearance shown in the cross section in figure 11. The free air must be entirely excluded; otherwise bacteria which cause putrefaction will enter and spoil the silage.

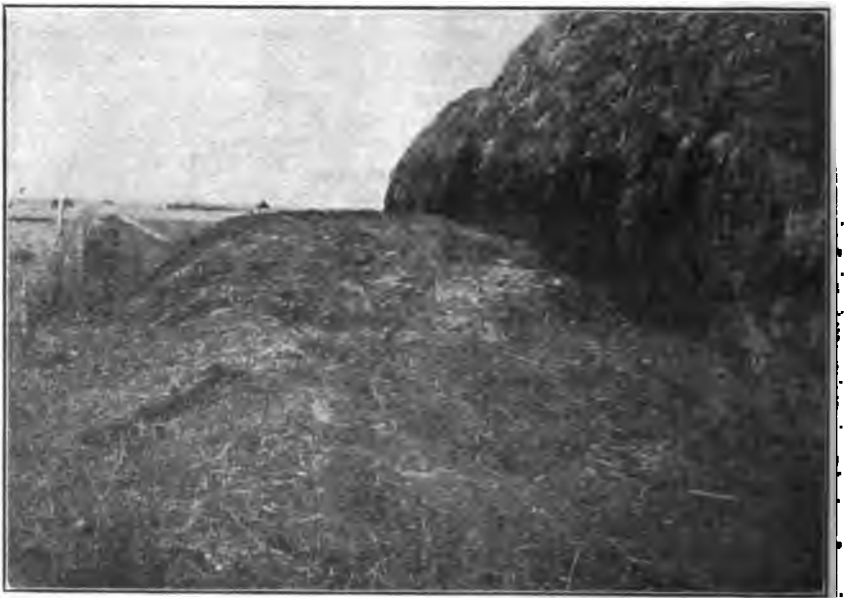

FIG. 10.—A beet-top silo above the ground level. In this instance, the tops were piled alongside a stack of hay. After packing them down thoroughly, they were covered with several inches of fine, chaffy straw, which effectually sealed the fermented mass. Analyses showed a quality of silage that compared with the best. With this type of silo, the ratio of spoilage is greater, but the plan is entirely feasible, particularly where the water table prevents excavating for the earth silo.

METHODS OF PACKING.

With the horizontal silo it is a common practice to drive the team and wagon right through the silo from one end to the other. A gradual incline at both ends facilitates entering and leaving. In a few instances beet growers have driven a tractor over the tops in the silo. This is an excellent way to pack the mass thoroughly. Sometimes a boy will ride a horse repeatedly over the tops in the silo. It is imperative that the packing be thorough or the product will be disappointing.

SEALING THE SILO.

After the mass of tops has been well packed and the silo is ready to be closed, provision must be made to seal the mass as nearly air-tight as possible. Fine, chaffy straw spread to a depth of 8 or 10 inches is effective. Sometimes a thin layer of straw is spread and then 8 to 12 inches of earth is placed on top of the straw.

The best and most economical method of sealing consists in covering with beet pulp to a depth of a foot or more, as seen in figure 12, and is the method recommended. Those living too far from the beet-sugar factory to haul the pulp can afford to have a quantity shipped. Pulp is a good, cheap feed, and an excellent way to store it is on top of the silo. The fermenting of the beet tops generates a gaseous heat, which aids in ripening the pulp, thus making a superior feed. It also keeps the pulp from freezing in cold weather. Freezing has always been annoying to feeders in the colder districts. The silo should be located convenient to the feeding yards. It is worth while to have this mass of warm, processed, high-grade feed near to the feeding yards rather than to depend upon hauling supplies throughout the

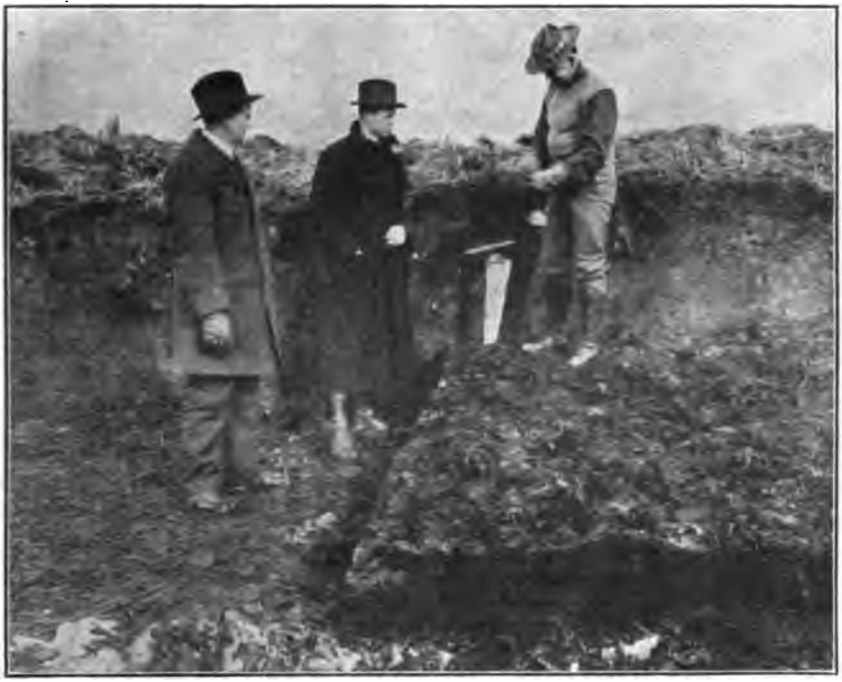

Fig. 11.—A cross-sectional view of a large beet-top silo, illustrating the manner of cutting out and removing the silage. An ordinary hay knife is used to cut the silage. It will be observed that the top contour of the silo is rather regular, showing that the filling and packing were uniform and thorough.

winter, when the roads and weather are forbidding much of the time. The wet pulp is heavy and flexible and aids to settle the mass of tops.

OPENING THE SILO.

A hay knife (see fig. 11), such as is commonly used on most farms, will cut the cured silage and pulp covering into "bents," much as a rick of hay is cut down when the hay is being taken away. The cured pulp may be fed in the same way that the silage is fed. The covering for the silo should be so rounded that drainage will be perfect. Surface water should not be permitted to stand around or on the silo.

After the mass has fermented for a period of four to six weeks, the large hay knife may be used and the silage cut across one end, from top to bottom, and forked out as needed. When spring arrives, any unused part of the silage may remain for future use. There will be some spoilage if the silage is exposed. The same precautions should be observed about spoilage as will be necessary in feeding corn silage from a regular structure. Any fermented product is liable to be attacked by bacteria that cause decay if exposed to the air for any considerable length of time. Precaution in this respect is not so important in the winter as during the warm spring and summer months, when bacteria are more active

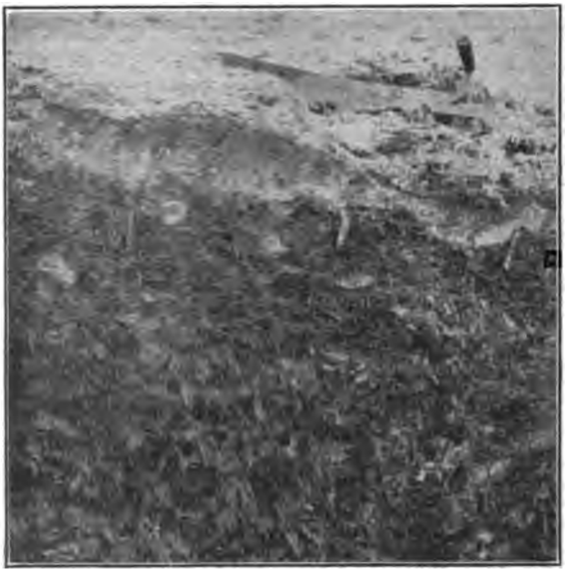

FIG. 12.—Sectional view of a beet-top silo that was covered with beet pulp. The pulp is heavy and flexible and settles as the tops in the silo settle. It seals the top of the silo, and the heat from the fermenting silage keeps the pulp covering from freezing. This is an excellent way to store green pulp.

WET BEET PULP.

The value of beet pulp as a supplemental feed becomes better established with the experience of each succeeding season. It is not a complete feed and should always be given in conjunction with a legume hay and other feeds. It is fed to beef cattle and sheep and also to dairy stock. When given to dairy cows it should be fed after the milking period in order to avoid the possibility of a bad odor and a disagreeable taste in the milk. Pulp is heavy to handle and to haul. Where feeders are conveniently near to a factory pulp silo it is a common practice to haul the pulp as wanted during the winter. The gases caused by the fermenting process keep the mass of pulp in a large silo from freezing in cold weather. The best way for the average beet grower to store the pulp on the farm is to spread it on top of the fermenting mass of beet-top silage. Freezing is thus largely eliminated.

DRY BEET PULP.

Some beet-sugar factories have installed equipment for drying the green pulp. By this process the moisture content of 95 per cent is reduced to 12 per cent. The feeding value is but little changed. The use of this process makes it possible to ship the pulp to more distant markets, and it also obviates annoyance from freezing.

UTILIZING BEET MOLASSES.

The most economical way to use beet molasses is to make a mixture with chopped or ground alfalfa hay or straw. Mixing devices are arranged to deliver a definite percentage of molasses and automatically to distribute the mixture uniformly. Where chopping or grinding devices are not available, it is entirely possible to make economical use of the molasses by sprinkling it over hay, straw, or pulp at feeding time, using a hand sprinkler. The Colorado Agricultural Experiment Station shows a value for beet molasses in equivalent terms of 1 pound of molasses equal to three-quarters of a pound of rolled barley. In addition to the intrinsic value of molasses it has a supplemental value, because it is appetizing to stock, apparently lending a zest to their use of other feeds.

Beet molasses is not recommended for feeding to pregnant cows, sows, or ewes, nor to pigs, calves, colts, or young lambs. Care must be used in feeding molasses to horses. Only a limited quantity should be fed, and it should be thoroughly mixed with other feeds.

DIGESTIBLE NUTRIENTS AND BALANCED RATIONS.

In a paper which was read before the American Association of Sugar-Beet Agriculturists at the recent convention at Logan, Utah, Mr. R. C. Kibbey, of Colorado, offered the following:

> Comparing the relative total digestible nutrients contained in 100 pounds of corn with those contained in an equal weight of sugar-beet by-products, we have the following: Corn equals 1; beet molasses, 0.68; dry beet pulp, 0.87; wet beet pulp, 0.09; beet-top silage, 0.21; dry beet tops, 0.64.

TABLE I.—*Sugar-beet by-products, showing the maximum weights of each which may be profitably included in rationing different classes of animals.*

Classes of stock.	Weight of ration per head per day (pounds).					
	Beet tops.		Pulp.		Molasses.	Tails, fresh.
	Siloed.	Dried.	Cured.	Dried.		
Fattening steers (1,000 pounds weight)	30 to 40	20	60 to 100	6 to 10	4	40
Fattening cows (800 pounds weight)	32	16	80	8	3	32
Young cattle (600 pounds weight)	24	12	40	4	2	25
Fattening bulls (1,200 pounds weight)	48	24	150	15	5	50
Dairy cows	30	15	60	6	3	25
Fattening sheep	3	1½	10	1	3	4
Ewes suckling lambs	3	1½	10	1	....	4
Fattening hogs	....	3	....	2	1½	3

MANAGEMENT OF SEED-BEET FIELDS.

GRAZING SEED BEETS.

When the crop of beet seed is harvested, there remains in the ground the seed beets. These beets weigh from 6 to 10 tons per acre. The sugar content ranges from 5 to 8 per cent or more.

Sometimes irrigation water is turned into the field as soon as the beet seed is harvested. Following the irrigation a rank growth of green tops comes on and furnishes excellent grazing for cattle or sheep during the months of September and October.

Another method is to plow the beets out of the ground, so they will be readily available, and then graze them with sheep or other stock. If the beets are left exposed to the sun and elements very long they become hard and fibrous.

SILOING SEED BEETS.

Experiments indicate that it is entirely feasible to chop the seed beets so they may be packed into a mass in a silo, in much the same way that beet tops are packed. An excellent quality of silage can be made, and it may be fed at any convenient time. Silage in this form has a fattening value comparable to beet-top silage.

UTILIZING BEET TAILS.

At the factory beets are carried from the storage bins in flumes filled with water. As they go over the dumps and through the various conveyors the tips, or tails, of the beets are broken. At intervals catch basins accumulate these tails, and they are forked into piles near the beet end of the factory. From 2 to 4 tons a day accumulate at each factory in this way. They may be fed while fresh or may be put into a beet-top silo. In either case they make excellent feed. In one instance where the beet tails were siloed it was found that sheep and other stock preferred this silage to that made from beet tops.

SUMMARY.

A good crop of beets will yield from 3½ to 6 tons of processed silage.

The average cost of gathering the tops and filling, packing, and finishing the silo is about $1 a ton.

It is extremely important that the tops be gathered and put into small piles promptly after the beets are topped. The dirt may be easily shaken from the tops while the leaves are still fresh. *It is imperative that dirt and sand be eliminated.*

The fundamental factors that are involved in making good corn silage also apply in making beet-top silage. Pack the mass thoroughly to exclude the free air and then seal tight. Good silage requires thorough packing.

It is not necessary to run the tops through a silage cutter. Some feeders prefer to do so, however, to avoid the possibility of lambs choking on the crowns.

The same structure that is commonly used for putting up corn silage may be used for beet-top silage. Because beet tops pack in a very dense mass, the structure will sometimes crack and spread and thus allow air to enter. A well-built silo is reasonably safe.

Making beet-top silage does not necessarily involve a cash outlay for materials. The natural earth silo and stacking above the earth are both successful. Concrete side retaining walls are advisable under certain conditions, however.

The natural earth silo will yield just as good results for beet-top silage as the perpendicular structures, but greater care in packing is necessary.

An excellent quality of silage is made by stacking the tops entirely above the earth and then packing them thoroughly. The spoilage loss is greater than when the structure or the pit silo is used.

It is not necessary to alternate layers of tops with layers of straw. It is always advisable to put a layer of straw next to the earth bottom and sides, to eliminate dirt from the silage. When straw is intermixed with the tops more packing is necessary.

Silage is not a balanced ration. It should always be supplemented by other feeds.

Silage is a carbohydrate feed and balances with alfalfa hay, which is rich in protein.

The fermenting process in the silo largely corrects the cathartic salts in beet tops.

The most profitable use is made of beet tops when they are siloed and fed with alfalfa hay or other forage and possibly supplemented with grain or concentrate feeds.

Gathering beet tops from the field and siloing them without undue delay allows fall plowing to be done before freezing weather interferes. Fall plowing is important for the beet crop.

The best feeding practices have demonstrated that by the use o beet-top silage in the ration the hay requirements may be reduce by one-half in feeding for the production of beef, mutton, or mil The succulent value of the silage supplements its actual feedin properties and that of forage and other feeds.

Unwise feeding practices will produce bad results in feeding sil or molasses. A systematic study indicates that the losses have be due to the manner in which silage is fed or to an excess of di rather than to be fed.

Beet-top silage will increase the flow of milk of ewes at lambi time. It is best to start feeding only about 1 pound per head dai and gradually to increase the quantity to 3 pounds per day. T udder may become feverish if this caution is not observed.

The most economical use of beet-top silage calls for about pounds daily for each steer or cow and about 3 pounds for ea sheep. Always begin with a light ration.

Beet molasses has a definite feeding value, particularly when mix with chopped or ground hay or straw. Successful feeders recogni its value when given in regulated quantities.

The best way for the beet grower to store pulp for winter feedin is to spread it over the beet-top silo. It effectually seals the sila mass, and the heat from the silage warms the pulp and thus haste the curing process; it also reduces the annoyance of handling fro pulp.

The limiting factor in growing sugar beets is usually the acre that can be suitably fertilized and fitted for the crop, due rega being given a crop rotation. More feeding on the farm means mo manure for the fields.

The economic utilization of beet tops and other by-products no only yields a direct profit by feeding to stock, but greatly assists i maintaining soil fertility and also in establishing a better cr rotation.

The by-products of the sugar-beet crop when properly handled fed have a value equal to the entire cost of what is commonly te "hand labor" in producing the crop of beets.

The best practices of feeding the by-products of the sugar crop will yield a net profit equal to half the net profits usually in growing and marketing the crop of beets.

It is safe to conclude that 1 ton of good beet-top silage is eq to half a ton of alfalfa hay when fed as a mixed feed. Many fe think that the silage has a value almost equal to good hay, ton for

Beet-top silage comes out of the silo warm in the winter, an is appetizing. It seems to stimulate the assimilation of food an aid the animal to appropriate the maximum values from all the consumed.

The silo brings the feed near the feeding yards and mini waste.

WASHINGTON : GOVERNMENT PRINTING OFFIC

A1.9:1096

FARMERS BULLETIN 1096
United States Department of Agriculture

FROST and the PREVENTION of DAMAGE BY IT

ALL FROST PROTECTION METHODS, from the simplest to the most complicated, can be carried on more successfully if the processes by which the earth's surface cools at night and the factors which influence the rate of cooling are well understood.

In the first part of this bulletin an attempt has been made to describe in a simple, elementary manner the changes that take place at and near the earth's surface on a frosty night, so that persons protecting plants or trees may be able to understand how their protective devices operate to prevent damage and in what manner they are most efficient. In treating a matter of this kind it is practically impossible to eliminate all technical terms, but so far as possible these have been carefully explained in simple language.

The larger portion is given over to a discussion of the various methods and devices now being used for protection against frost, together with a chapter on temperatures injurious to plants, blossoms, and fruit.

Contribution from the Weather Bureau
C. F. MARVIN, Chief
Washington, D. C. April, 1920

A 1.9:1096

Prepared by
FLOYD D. YOUNG
Meteorologist, Weather Bureau.

FROST AND THE PREVENTION OF DAMAGE BY IT.

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FROST DEFINED

WHAT IS FROST?

The words "frost" or "hoar frost" are used to designate the deposit of feathery ice crystals which usually form on the ground or other exposed surface whose temperature has fallen to 32° F., the freezing point of water, or lower. In a larger sense, the occurrence of any temperature of 32° F. or lower, whether accompanied by a deposit of ice crystals or not, is called a frost.

Frosts are spoken of as light, heavy, or killing, depending on the degree of damage to growing crops. Since the same temperature that kills young tomato plants may not injure fruit blossoms, a frost that would be called "killing" by one person may be regarded as "light" by another. During the growing season a period of extremely cold weather accompanied by strong winds, when the air for a considerable distance above the earth is chilled, is sometimes called a "freeze." True frosts occur only when the surface air is relatively calm.

In order to understand the underlying principles of frost protection it is necessary to know something of the methods by which the ground surface and lower air cool during the night.

HOW FROST IS FORMED

Whenever two objects or portions of the same object are unequally heated, the colder always gains in temperature at the expense of the warmer, the tendency being to equalize the temperature throughout every portion of the bodies. The interchange of heat is accomplished in two ways, radiation and conduction, each of which will be discussed separately as it bears on the matter of the occurrence of frost.

Radiation.—The heat and light from the sun come to us through space in a form of wave motion called radiation. The atmosphere offers considerable obstruction to the passage of these waves. Even when the sky is very clear, rarely more than 65 per cent of the radiation penetrates to the surface of the earth, the part absorbed being expended in raising the temperature. The region near the upper limits of the atmosphere is one of intense cold. As the sun, having a much higher temperature than the earth, radiates heat to the earth, so from the surface of the earth heat is radiated to the much colder upper limits of the atmosphere.

The radiation of heat from the earth is continuous both day and night when there are no clouds or other obstructions between the earth and the upper atmosphere. During the day the amount of heat received from the sun is so much greater than the amount lost by radiation from the earth that the temperature rises. After the sun sets, however, no heat is received to counterbalance the loss by outgoing radiation and the temperature falls.

Conduction.—Heat may be interchanged between different portions of the same body, or between two separate bodies in actual contact, by conduction. When one end of a bar of iron is held in a fire, the end away from the fire soon becomes too hot to hold in the hand. The heat is transferred from the hot portion of the bar to the cooler portion by conduction. The shortness of the time taken for the heat to reach the cooler end of the bar indicates that iron is a relatively good conductor of heat. On the other hand, one end of a stick of wood can be held in the fire until it is completely consumed without the other end becoming very warm; therefore wood is a poor conductor of heat. Of course, if the stick ceased to burn and the heat in the burning end were not lost, the heat in the warm end would eventually be distributed equally throughout the stick. Both the soil and the air are very poor conductors of heat.

During a clear, calm day the temperature of the ground surface is raised by the heat received by radiation from the sun and the air in immediate contact with the ground becomes warmed by conduction. Since the air is so poor a conductor, the increased temperature of the ground is imparted to only a very thin layer of air at first. However, as soon as a small portion of this layer becomes warmer than the air above and around it, its density is lessened and it is forced upward and replaced by the cooler and denser air near by or above. This air is also warmed in turn by conduction from the ground and rises to make room for more cool air. The heated air continues to rise until it reaches a point where its temperature is the same as that of the air surrounding it. This process continues until, near sundown, the temperature of the air is highest near the ground and decreases at a more or less uniform rate with increased distance above the ground up to a height of a thousand feet or more.

After the sun goes down the ground cools rapidly through radiation, and its temperature soon falls below that of the layer of air in contact with it. As soon as this occurs the surface air begins to lose heat to the ground by conduction. The air near the ground now becomes cooler than the air above and its density becomes increasingly greater. Instead of rising, as did the surface air during the day, its increased density tends to keep it in contact with the ground. Thus over a level plain on a clear, calm night we find a relatively thin layer of cold air near the ground with an increase in temperature up to an altitude of between 300 and 800 feet.

Air Drainage.—Over gently sloping ground the force of gravity tends to cause this thin surface layer of cold air to move down the slope and to gather in depressions in somewhat the same manner as water. The similarity between the flow of water and of air down a slope is inexact, however, because of the difference between the physical characteristics of air and water. Water is a practically incompressible liquid; therefore neither its volume nor its density is much affected by a change in pressure. Air is a compressible gas and its physical condition is influenced greatly by such a change. The atmosphere exerts a pressure at sea level of about 15 pounds to the square inch. Because of its compressibility, the density of the air decreases rapidly with increase in altitude. In accordance with a law governing the behavior of gases, a decrease in density is accompanied by a decrease in temperature and an increase in density causes an increase in temperature. When air moves downward along a gentle slope or a steep hillside, its altitude is constantly decreasing and its pressure and density are constantly increasing. The increase in density causes an increase in temperature (heating by compression) at the rate of about 1.6° F. for every 300 feet decrease in elevation and an increase in elevation causes a decrease in temperature (cooling by expansion) at the same rate, provided there has been no loss or gain of heat from other sources.

Over a gently sloping plain or valley floor it is possible for the cold surface air to drain down the slope in much the same manner as water, as the vertical movement of the air takes place so slowly that the heating effect due to decrease in altitude is more than offset by the cooling due to contact with the ground which has been cooled by radiation. When we are dealing with a steep hillside, however, movements of the surface air are more complex and have little similarity to the flow of water down the same slope.

Like the more nearly level lower ground, the slopes and summits of hills and ridges lose their heat rapidly after sundown through radiation, and their temperature falls. The air in immediate contact with them also cools through conduction so that it is soon cooler than the air at some distance out over the valley, but at the same elevation.

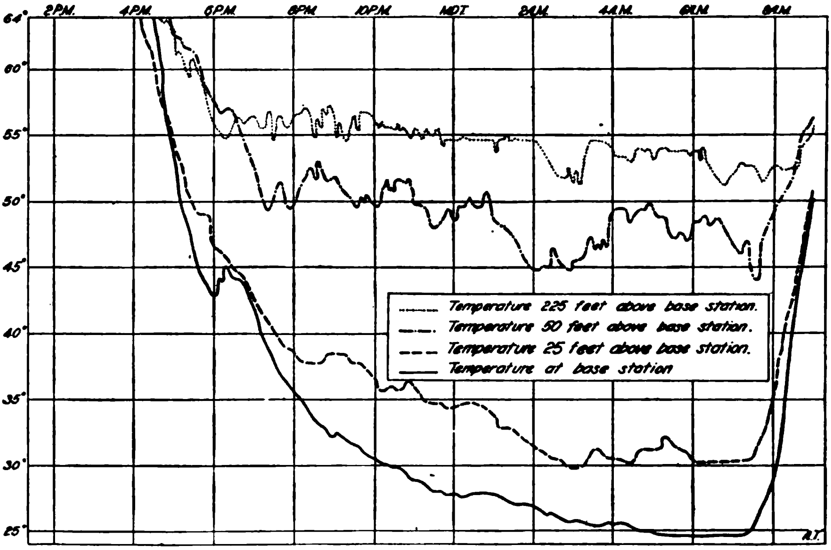

FIG. 1.—Continuous records of the temperature from 4 p. m. to 9 a. m. at the base and at different heights above the base of a steep hillside, showing the great differences in temperature that sometimes develop on a clear, still night. Although the temperature at the base was low enough to cause considerable damage to fruit, the lowest temperature 225 feet above on the slope was only 51°. Note that the duration of the lowest temperature was much shorter on the hillside than at the base.

If this cooler air in contact with the hillside begins to flow downward directly along the surface of the ground, its altitude will be decreasing more or less rapidly, according to the steepness of the slope, and its density will be increasing. If no further cooling takes place, it will be surrounded by air increasingly colder as it nears the valley floor, while its own temperature tends to increase because of the compression it suffers. As soon as a position is reached where it is warmer than the air surrounding it, its downward movement will be checked and it will tend to rise again until its temperature is the same as that of the air surrounding it. (See fig. 1.)

The drainage of cold air down a valley floor is usually interfered with considerably by outside influences. As soon as the flow begins there is more or less mixing of the cold lower air with the warmer upper air and inequalities in barometric pressure over whole regions may temporarily prevent the flow or even reverse its direction for short periods. Local winds of slight velocity and covering a very limited area often cause a mixing of the air that causes the surface temperature to rise suddenly from 5° to 10°. It is not often possible to know in advance that the drift of the air on a valley floor will continue from one direction during a cold night, though there may be one particular direction from which it very seldom comes.

Effect of Water Vapor on Rate of Cooling.—Water vapor is the most effective of the various gases present in the atmosphere in obstructing radiation of heat from the earth. Therefore, the amount of water vapor present in the atmosphere above a given locality has considerable influence on the rate of fall in temperature at that place during the night; the temperature falls more slowly when the humidity is high than when it is low, other conditions being the same.

The amount of invisible water vapor in the atmosphere varies greatly at different times. At a given temperature only a certain maximum amount can be present. If, when the maximum amount is present, the temperature is lowered, a certain portion of the water vapor is changed to liquid or frozen water, as the amount of water vapor which can be present in the air is greater when its temperature is high than when it is low. No matter how dry the air under natural conditions may be, if its temperature be lowered sufficiently, a point will be reached where the invisible vapor will begin to appear in a liquid or frozen form. The temperature at which this condensation begins is called the dew point. The drops of moisture which appear on the outside of a pitcher of ice water on a warm day are formed through the chilling of the air in contact with the pitcher. These droplets begin to appear on the pitcher as soon as its temperature has reached the dew point.

The actual amount of water vapor in the air expressed in terms of weight per given volume of air, is called absolute humidity. With a given dew point the absolute humidity is always the same; therefore to determine the absolute humidity it is only necessary to find out what is the temperature of the dew point.

As a general rule the temperature of exposed objects falls more or less steadily after sunset until it reaches the dew point, at which time the invisible water vapor in the atmosphere begins to be deposited on them. If the dew point is above 32° F., the freezing point of water, dew is formed; if it is 32° F. or lower, frost forms. Since dew or frost does not begin to form until the temperature of the ground or other object reaches the dew point, it is apparent that if the dew point is very low, the temperature may fall low enough to cause considerable damage without the formation of any frost. For example, if the dew point is 18° F. and the lowest temperature reached during the night is 24° F., there will be considerable damage to growing crops without any frost whatever. This phenomenon, often called a "black frost," is of rare occurrence in most localities.

Another factor that has great influence on the amount of fall in temperature during the night is the liberation of latent heat in the formation of dew and frost. A definite amount of heat is required to raise the temperature of a given amount of water to the boiling point without vaporizing any of it. After the boiling point is reached, another definite amount of heat is required to convert this water into water vapor, the temperature of the water remaining unchanged during the vaporizing process. This latent heat, stored up in the water vapor, is released whenever the water vapor is again changed to a liquid state. A portion of the sun's heat during the day is expended in evaporating moisture from the ground and from the leaves of plants. When the dew point is reached at night and vapor is condensed, its latent heat is given up. The amount of heat given up on a particular night depends on the amount of moisture precipitated. Obviously, the greater the amount of moisture in the atmosphere, the more will be condensed, provided the temperature falls below the dew point. When the dew point is high, the latent heat given off in the formation of dew is often sufficient to check the fall in temperature almost entirely. Generally speaking, therefore, other conditions being equal, the higher the dew point in the evening the less danger there is of the occurrence of a damaging frost.

WHEN TO EXPECT FROST

The weather in the latitude of the United States is controlled by atmospheric disturbances of great size and varying intensity, which follow one another across the country, moving from west to east. These disturbances are of two types, one of which is marked by low barometer, overcast skies, and rain or snow; the other by high barometer and clear skies.

The main factor in the occurrence of frost is radiation of heat from the earth. When heavy lower clouds cover the sky, they act as a blanket and prevent radiation to the upper limits of the atmosphere, making impossible the occurrence of a true frost. A moderate wind is also generally effective in preventing frost. The formation of a thin layer of cold air near the ground is prevented on a windy night by the mixing of the surface air with the warmer air above.

The important requirements for the occurrence of frost, a clear sky and little wind, are present during the passage of an area of high barometer. As the first-mentioned type of disturbance, the area of low barometer with overcast skies and rain, nearly always precedes the area of high barometer, the saying in many sections of the country, "Three days rain and then a frost," has some basis.

During the passage of a well-defined area of low barometer the radiation from the sun is more or less completely cut off by heavy clouds and the ground is not warmed much during the day. If rain has fallen, the evaporation from the wet ground uses up a great deal of heat and this also tends to keep the temperature low during the day. Therefore, on the first clear night after a rain during the frost season the temperature at sunset is likely to be within 15° or 20° of the freezing point and not much cooling by radiation is necessary to form frost, although frost is not expected in many cases on the first night on account of wind conditions.

Though the moisture in the ground after a rain tends to prevent warming of the ground during the day, it also tends to prevent a large fall in temperature during the night. The water vapor taken up by the atmosphere from the wet ground diminishes radiation. When the dew point is reached the latent heat given up checks the rate of cooling still more, and when the freezing point is reached the conversion of the ground moisture into ice also liberates heat and aids in preventing a further fall in temperature.

Before the second night after the rain the surface of the ground has usually dried out considerably. The dew point is likely to be lower and a more damaging frost is likely to occur at that time. Before the third night the day temperature has usually risen high enough to make unlikely the occurrence of a heavy frost on the Pacific coast, while in the central and eastern part of the United States frost may occur as late as the fourth night if the high pressure area is well defined and moves slowly.

Large bodies of water exert a modifying influence on the climate of localities to the leeward and such localities do not often suffer much damage from frost. A light wind blowing from a large body of water is generally more or less laden with water vapor, which cuts down the rate of radiation; and as the temperature of the water is usually considerably above freezing, the temperature of the air passing from it to the land is high enough to prevent the formation of frost.

Rivers often give up a large amount of moisture to the surface air so that when the temperature falls to the dew point a fog forms which covers a part or all of the lower land in the valley, cutting off radiation and preventing a further fall in temperature.

In valleys near the ocean, fog sometimes drifts in from the water toward morning and prevents a damaging frost. On nights with fog the hillsides are practically always colder than the lowlands unless the fog extends high enough to cover both hillsides and valley floor.

INFLUENCE OF SOIL AND VEGETATION ON MINIMUM TEMPERATURE

In experiments carried on in the cranberry bogs of Wisconsin, Prof. H. J. Cox found differences of from 5° to 10° F. between minimum temperatures registered on the surface of level ground at two points within 6 feet of each other. The ground at the warmer station was bare, while that at the colder station was covered with spaghnum moss. The soil at both points was peat. At a height of 3 feet above the ground this difference in temperature disappeared.

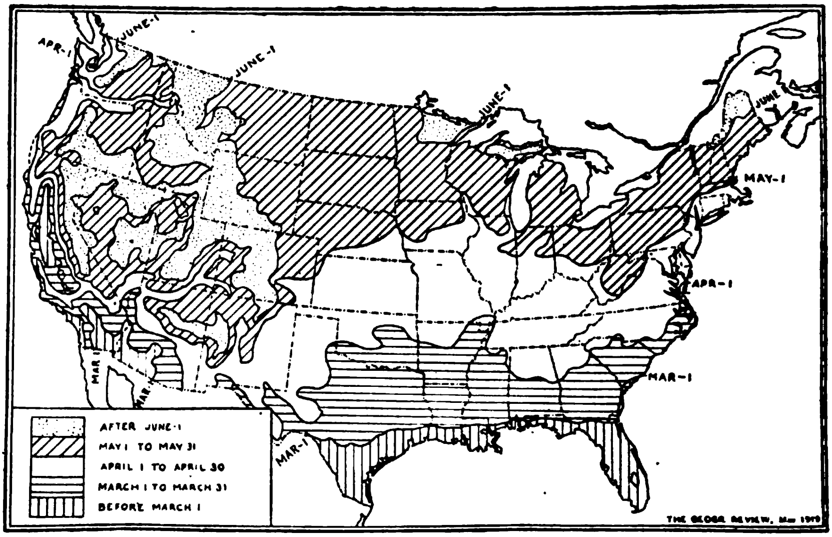

FIG. 2.—Average dates of last killing frost in spring.

Prof. Cox attributes this difference in temperature to unequal warming of the bare and moss-covered soil during the day and unequal conduction of heat to the surface from below during the night. The soil at the cooler station was shaded by the moss and a large part of the heat received during the day was expended in evaporating water from the plants, while at the warmer station the sun shone directly on the soil, warming it to a greater depth. At night the heat absorbed during the day was slowly conducted to the surface of the bare ground while most of the smaller amount of heat absorbed by the moss-covered ground was prevented from reaching the thermometer because of the intervening moss, which is a poor conductor of heat.

It was also found that the temperature often fell several degrees lower at night over wet ground than over dry ground, because of the heat expended in evaporating moisture from the wet ground during the day. By covering the bogs with coarse sand, the moisture is prevented from rising to the surface from below, and cooling by evaporation is checked. By keeping the bog free from weeds, draining, and sanding, damage by frost may be greatly lessened.

PROTECTION FROM FROST

Since a crop which represents the results of the labor and care of an entire season may be destroyed by frost in a single night, various methods of protection against frost have been practiced for centuries in different parts of the world.

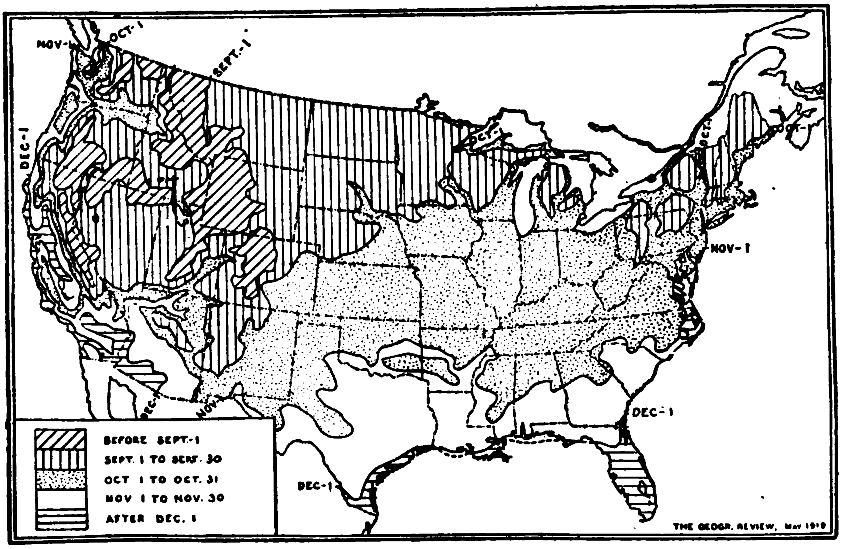

FIG. 3.—Average dates of first killing frost in fall.

The three general principles used in frost protection devices in the United States are:

(1) Conserving heat, (2) Mixing or stirring the air, and (3) Adding heat.

CONSERVING HEAT

The most important method by which the ground cools during the night is radiation. If it is possible to prevent radiation or reduce it sufficiently, the ground heat will be conserved and there will be no damage. This may be partially accomplished by covering the ground or plants with various materials.

Covering with Glass.—Glass is one of the best materials known for screening plants and preventing frost damage, since it is almost impervious to the waves of outgoing radiant heat from the earth, but allows the incoming heat from the sun to pass through it freely. The expense of covering with glass is too great to allow of its use except for the more expensive plants and flowers.

Cloth Screens.—Experiments have been carried on in California and elsewhere to determine the value of a covering of cloth over orchards and over individual trees. When an acre or more of orchard is thus covered, the minimum temperature may be from 2° to 4° higher inside the covered area than outside, if there is little air movement. In experiments carried on in cooperation by the Weather Bureau and the Southern Oregon Experiment Station of the Oregon Agricultural College, it was found that cloth coverings over small areas of orchard or over individual trees do not have an appreciable effect on the temperature, even when the coverings are of heavy cloth or canvas. This is due to the fact that the cloth does not prevent an interchange between the air under the covering and that outside.

Coverings of rather heavy cloth laid directly over garden truck or other low-growing plants are effective in protecting against moderate frosts. In this case radiation from the ground and plants is almost completely cut off and the air movement is so slight near the ground there is little tendency for the cold outside air to be forced under or through the covering. The temperature of the surface of the cloth exposed to the sky is lowered by radiation and may fall to a low point, but as both the cloth itself and the air underneath the cloth are very poor conductors of heat, the temperature of the covered plants falls much more slowly. The heat which has penetrated a few inches into the ground during the day is slowly conducted to the surface during the night and aids in keeping the temperature under the cover above the freezing point.

It is evident from the above that coverings of this kind should be placed early in the evening when a frost is expected, before much of the heat accumulated in the soil during the day has been lost. Tin cans or other metal coverings should not be used to protect plants from frost damage. Metals are good radiators and conductors of heat and the temperature is likely to fall nearly as low under a covering of this kind as in the outside air.

Lath Screens.—Screens made of laths fastened together with wire (the spaces between them being about the width of the laths) have been used in Florida and California to protect orchards. These screens serve not only to diminish outgoing radiation during the night but also as a shade from the sun. About three-fourths of the sky is screened by a covering of this kind. By placing the laths in north and south directions the direct rays of the morning sun are completely cut off, which permits of a slow thawing of blossoms and fruit after a heavy frost. This reduces the amount of injury.

Orchard heaters burned under screens of lath or cloth are more effective in raising the temperature than is the case when they are burned in an uncovered orchard.

Other Methods.—Paper covers may be used to protect small individual plants or large paper strips may be used to protect gardens against light frosts. Generally speaking, paper coverings do not afford as much protection as those made of cloth.

Young potatoes and garden truck are sometimes protected by plowing a furrow between the rows and covering the plants with soil.

Cranberry growers in the marshes of Massachusetts, New Jersey, and Wisconsin flood the marshes with water from large reservoirs when frost is expected. For protection against a light frost it is generally sufficient to raise the level of the water in the ditches. For a moderate frost the water level is raised to the surface of the bog and when a heavy frost is expected the vines themselves are covered with water. In the first two instances protection is afforded by the heat given off by the relatively warm water.

Devices for Adding Moisture to the Air.—Smudge fires of damp straw or manure have been used to create a blanket over the area to be protected, the object being to decrease the radiation from the ground rather than to add heat to the air. It is possible that such a method may be successful when the air is calm and is already nearly saturated with moisture. However, heavy frosts generally occur when the humidity is fairly low and a perfectly calm surface air is seldom met with on cold nights; there is usually at least a slow movement down gently sloping valleys or plains. In a relatively dry atmosphere any moisture thrown off by damp smudge fires will be rapidly lost by circulation and diffusion into the great quantities of air above and surrounding it, and the effect in diminishing the rate of radiation will be very small. At the same time, if an effective blanket of moisture could be spread over the orchard, a slight breeze would carry it steadily away, replacing it with cold outside air that has been chilled through contact with soil from which radiation had gone on unchecked.

Spraying of trees to afford protection from frost has been attended with some success. However, it is not possible to combat a heavy frost in this way on account of the heavy coating of ice formed, which strips leaves and even large branches from the trees. If the tree is in bloom the water is likely to cause damage by interfering with pollination. These objections do not have so much weight in the case of protection of garden plants, and spraying with water may be very effective where these are concerned.

Good results have been obtained by turning fairly warm irrigation water into fields or orchards on moderately cold nights. This method will not afford protection against damage by heavy frosts. Frequent irrigation of citrus trees during the winter months may start new growth and render the trees much less resistant to cold.

STIRRING THE AIR

The temperature of the air 40 feet above the ground is often from 7° to 10° higher than that 1 foot from the ground. It is obvious that if the air within this distance from the ground could be mixed, a damaging frost would not be likely to occur in most cases. Attempts have been made to do this with large power-driven fans, but it was found that the expense was far too great for the plan to be considered from a practical standpoint.

ADDING HEAT

The third principle of frost protection is concerned with the addition of heat to the lower air to replace that which is lost by radiation and conduction. This is generally accomplished by lighting a large number of small fires throughout the area to be protected. Oil, wood, coal, oil-soaked shavings, tree prunings, and carbon briquets, or a combination of two or more of these fuels is used.

Persons unfamiliar with temperature conditions in the lower air on frosty nights sometimes speak of the fallacy of attempting to "warm up all out-of-doors." It is well known that warm air is less dense and therefore lighter than cold air. This fact is exemplified in many ways in everyday life; the hot gases from a stove or furnace rising through a flue and the lifting power of the old hot-air balloons are good illustrations. As a matter of fact, roughly speaking, the warmed air continues to rise and cool until it reaches a point where it has the same temperature as the air surrounding it. On first thought it might be supposed that the air warmed by fires in orchards or fields would pass upward to a considerable altitude and be replaced by cold air from outside the heated area so rapidly that the effect on the air temperature in the heated area would be very slight. However, the factor of temperature inversion on frosty nights (the relatively thin layer of cold air near the ground with warmer air overlying it) completely alters the situation, in that the heated air does not rise far before it finds itself surrounded by air of the same temperature as itself. As the hot gases leave the fires, they mix rapidly with the surrounding colder air, so that the resulting temperature of the whole mass is not very high. When the air 40 feet above the ground is 10° warmer than that a foot from the ground, the heat from the fires is nearly all expended in raising the temperature of the air within this 40-foot layer. In other words, the warmer upper air acts as a roof which stops the ascent of the heated air. (See fig. 4.)

It is plain that the degree of temperature inversion near the ground, that is, the rate at which the temperature increases with increase in altitude, determines the thickness of the layer of air that must be warmed to obtain a definite increase in temperature at the ground. If the inversion is strong the surface temperature can be raised several degrees more than when the inversion is slight, the amount of fuel consumed being the same in both instances.

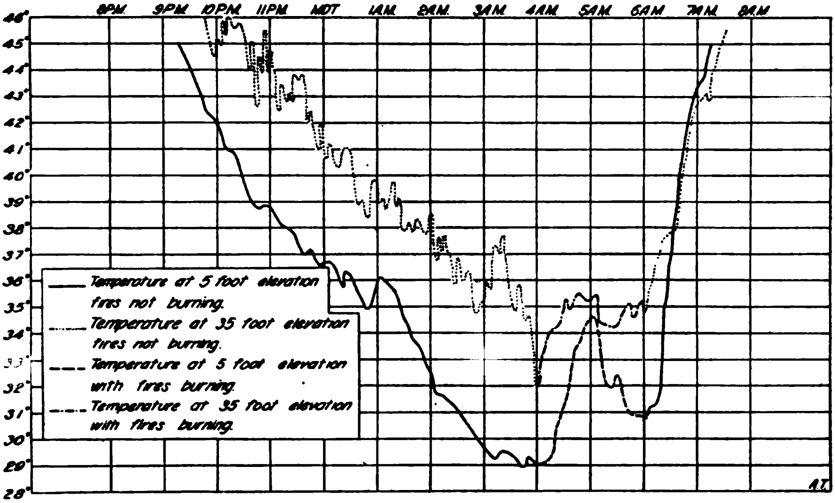

FIG. 4.—Continuous records of the temperature 5 feet and 35 feet above ground on a tower in a pear orchard. Note the large difference in temperature at the two levels before the orchard heaters were lighted at 4 a. m. By 5 a. m. the temperature was practically the same at the two levels, showing that the heat from the burning oil had been nearly all expended in raising the temperature of the air within 35 feet of the ground. This point is further illustrated by the fact that at 5 a. m. when most of the heaters were extinguished, the temperature at the 5-foot level fell rapidly, while it remained practically stationary at the 35-foot level.

The amount of this temperature inversion varies greatly from night to night, and in different localities. It is mainly determined by the amount of fall in temperature from afternoon to early morning. If the afternoon temperature is high and the temperature falls to freezing on the following morning the inversion in temperature is likely to be great.

A large number of small fires will be found to be more efficient in raising the temperature than a small number of large fires, especially in localities where the temperature inversion is relatively slight. The heated gases leave the large fires at a high temperature and tend to rise some distance above the ground, while the gases from a number of small fires are mixed with the surrounding cooler air until the temperature of the whole mass of surface air is raised slightly, although remaining still relatively low.

Another and probably the most important factor in protection by heating is the amount of air movement near the ground. When the air is calm the air warmed by the heaters remains over the fired area and the maximum results in raising the surface temperature are obtained. When the air is in motion, even though it is moving only a few miles per hour, the heat is steadily carried away and a greater quantity of fuel must be consumed to obtain the same effect on the surface temperature.

The matter of reinforcing the borders of an orchard with one or two extra rows of heaters is of the greatest importance. When the air is in motion, if there is no border row of fires, the heat from the first two or three rows of heaters on the windward side is carried into the orchard, leaving the outside rows practically unprotected. In such cases the temperature in the outside rows may show a rise of only 1° or 2° due to the firing, while the remainder of the orchard may be benefitted by a 5° or 6° rise. To secure the maximum amount of protection for border trees, a row of heaters, 10 feet apart, should be placed about 40 feet to the windward of the outside row, with a similar row about 20 feet to the windward.

The smoke cover has very little influence on the loss of heat by radiation and the effect of smudge fires of damp straw or manure on the temperature is practically negligible. However, a smoke screen is of some value in shading the fruit and blossoms from the morning sun and preventing a too rapid thawing.

Smudging and Pollination.—In some deciduous fruit districts it has been asserted that the smoke from the open oil heaters interferes with pollination. However, the experience of a large number of fruit growers, who for many years have smudged their trees while in full bloom, does not bear out this contention. Pollination usually takes place on the day the blossom opens and even if considerable soot is deposited within the flower on the following night, no damage results. As a matter of fact there is seldom enough soot deposited in a blossom to hinder pollination, even when firing is continued for several hours.

During the seasons of 1917 and 1918 Mr. B. B. Lowry, of Medford, Oreg., cooperating with the county pathologist, smudged six pear trees, including practically all varieties grown commercially in the district, every night from the time the buds began to open until the fruit had set, in order to note the effect on pollination. Three open lard-pail heaters were placed almost directly under each tree and the blossoms were coated with soot to an extent that would never be found in actual practice. The experiment was carefully checked by the writer during the 1917 season. All the smudged trees bore heavy crops both years and the yield of near-by trees that were not smudged was not noticeably larger. (See figure 5.)

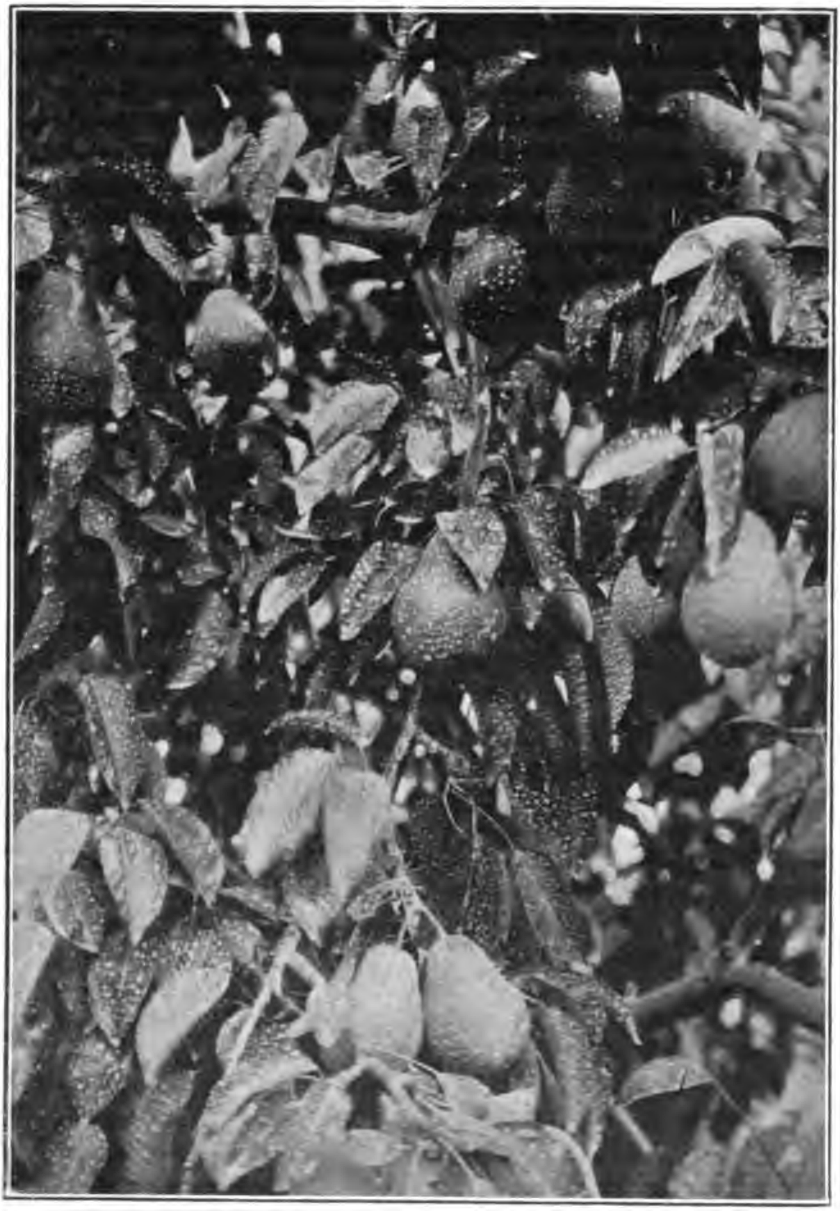

FIG. 5.—Fine crop of perfectly shaped Bartlett pears on tree used in experiments to determine the effect of smudging on pollination. This tree was smudged heavily every night from the time the buds began to open until the fruit had set. Photograph taken soon after spraying.

Statements that bees will not work in blossoms that have been smudged may be due to a lack of understanding of the habits of the bee. It is well known that bees will often not work on even moderately cool days; if the afternoon temperature is below a certain point, namely about 60° F, the bees may remain in the hive. On days following the occurrence of a frost heavy enough to make smudge protection necessary the temperature is likely to be sufficiently low to keep the bees from working to any great extent. On warm sunshiny days following heavy frosts, however, the writer has often observed great numbers of bees working in blossoms that had been heavily smudged on the previous night.

The smoke from the open heaters is very dense and in some localities the residents of towns have objected to orchard heating on account of the resulting dirt. The smoke problem has been partially solved by the development of improved heaters, but no practical heater has yet been devised that will burn under orchard conditions without giving off some smoke. The newer types are rather complicated and are too expensive to be used for the protection of crops that do not bring a large return. There are few commercial fruit districts in the country that do not suffer severely from frost damage at intervals, and in most localities people are willing to put up with some inconvenience from smoke on a few nights a year in order to avoid the business depression likely to follow the loss of a large portion of the crop.

Protection of Olives.—In some parts of California the olive crop is often damaged severely by fall frosts when the fruit is being picked. In some olive-growing communities as much as 70 per cent of the crop has been lost in some seasons in this manner. Many growers have hesitated to resort to orchard heating to save the crop for fear that the oil smoke would affect the flavor of the olives. Mr. F. Mier, of Fair Oaks, Calif., has been protecting his olives with open oil heaters for several years and has never been able to note any effect on the flavor of the fruit. Practically his entire crop has been packed ripe and has always been of the highest quality. It is unlikely that the oil flavor ever penetrates the thick, tough skin of the olive, but even if this were possible, the treatment with lye which the fruit is given to remove the bitter element would undoubtedly remove it.

Relative Value of Different Fuels.—The kind of fuel most suitable for use in a given locality depends on a number of factors. The first consideration is the relative cost of the different fuels. On the Pacific coast oil is used almost exclusively on account of its low cost as compared with coal or wood. In most other parts of the country coal is the cheaper fuel. The acreage protected by wood fires is relatively small. Because of the ease with which it may be lighted and extinguished, handled and stored, oil is to be preferred when its cost compares favorably with that of other fuels.

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Fuel oil of from 25 to 28 gravity is the most satisfactory for use in either the lard-pail or improved type of heater. This oil leaves very little residue and burns practically as long as heavier oils.

Types of Oil Heaters.—Up to the present time few deciduous fruit crops have been valuable enough to warrant the use of any but the simplest and cheapest types of heaters for protection against frost. Since good results can be obtained with these heaters (the lard-pail type) when a sufficient number to the acre is used, the only incentive to change to a more complicated type of heater is the abatement of the smoke and soot. The indications are that the smudge does not injure deciduous blossoms or fruit to any measurable degree and its elimination is desirable only on account of the resulting dirt.

The small open lard-pail heaters are not well suited for the protection of citrus fruits because (1) at the time protection is necessary the fruit is almost ready to be picked and even a small deposit of soot is likely to impair its marketing qualities, and (2) protection is necessary in midwinter, when the temperature is likely to remain below the danger point continuously for 10 or 12 hours and heaters of large capacity and long burning time are required.

A 5-quart lard-pail heater will burn about 2½ hours, but as the oil gets low the amount of heat given off is greatly decreased. The 2-gallon lard-pail heater will burn about 4 hours, but little heat is given off after 3½ hours.

The length of time the larger heaters will burn depends altogether on the amount the drafts are open. To combat the long cold periods, that sometimes visit the citrus districts, without refilling during the night, heaters of a capacity of about 7 gallons should be used. These will burn from 8 to 10 hours at near their full rate.

More than a score of more complicated heaters have been developed with the idea of improving combustion and reducing the amount of smoke. These run all the way from the 3 or 4-gallon capacity short-stack heater (fig. 6) to the high-stack heater of from 7 to 20 gallons capacity (fig. 7). The stacks on the smaller heaters are from 4 to 10 inches high, while on the larger heaters they are from 3 to 5 feet high. With one or two exceptions the "down draft" principle is used in all the improved types. Air is admitted through the top of the oil reservoir, causing the oil to burn there and raise the temperature sufficiently to change some of the oil to gas. The gas then passes upward and is burned as it rises through the stack. A supply of air to support combustion is admitted through holes cut in the base of the stack.

In order to burn clean and supply the desired amount of heat the gas must be given some time to burn before its temperature is reduced by mixing with the cold outside air. This is the function of the tall stack. Generally speaking, the high-stack heaters burn with less smoke and soot than any other type in general use. The short-stack heaters throw off less smoke than the lard-pail type, but the amount is large enough to be objectionable.

The high-stack type of heater is open to the objections that the heat is released too far above the ground, at too high a temperature and with too great an upward velocity to obtain the best results. These objections would probably be serious in localities where the temperature inversion is slight, but in southern California, where these heaters are in most general use, the temperature is often 20° higher on a cold night at a height of 200 feet above the ground than at the ground.

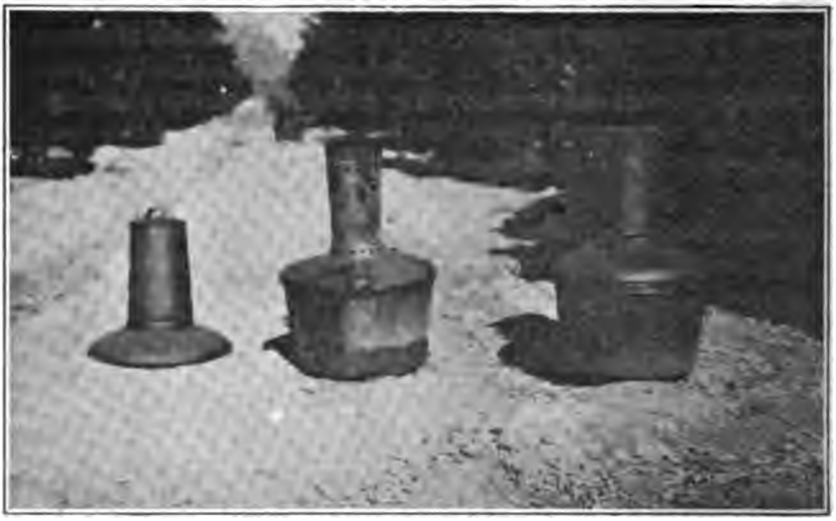


FIG. 6.—Short-stack oil heaters in orange grove. The one on the left has cover removed and draft open. This type of heater has given great satisfaction where there is not too much objection to the formation of heavy smoke.

There is no doubt the heat should be liberated as near the ground as possible in order to obtain the best results. However, at the present time the use of the high stack is the only practicable means of obtaining fairly perfect combustion. Some of the heat from these heaters is undoubtedly lost through its rising too high above the ground, but this is probably nearly offset by the additional heat obtained through the more complete combustion. The smoke and soot given off by other types of heaters are more or less completely consumed in the high-stack heater. It is estimated that from 40 to 50 per cent of the heat in the oil is made available in the lard-pail type, as against 70 to 80 per cent in the high-stack type.

The plan of using small oil heaters which burn slowly and setting them directly under the trees has not met with much success up to the present time. There is always danger of severely injuring the tree if the heater burns too high, and the problem of distributing the heat uniformly throughout the tree has not yet been solved.

Protection by Direct Radiation From Heaters.—Though protection from frost is afforded mainly through raising the temperature of the air by mixing with the hot gases from the heaters, direct radiation of heat to the plants or trees is important in some cases. This is particularly true when the high-stack heaters are used. When these are burned at a moderate rate at least a portion of the stack is likely to be heated to redness. The heat radiated from the stack to the fruit and foliage serves to counterbalance the loss of heat through outgoing radiation. The amount of radiant heat reaching the tree

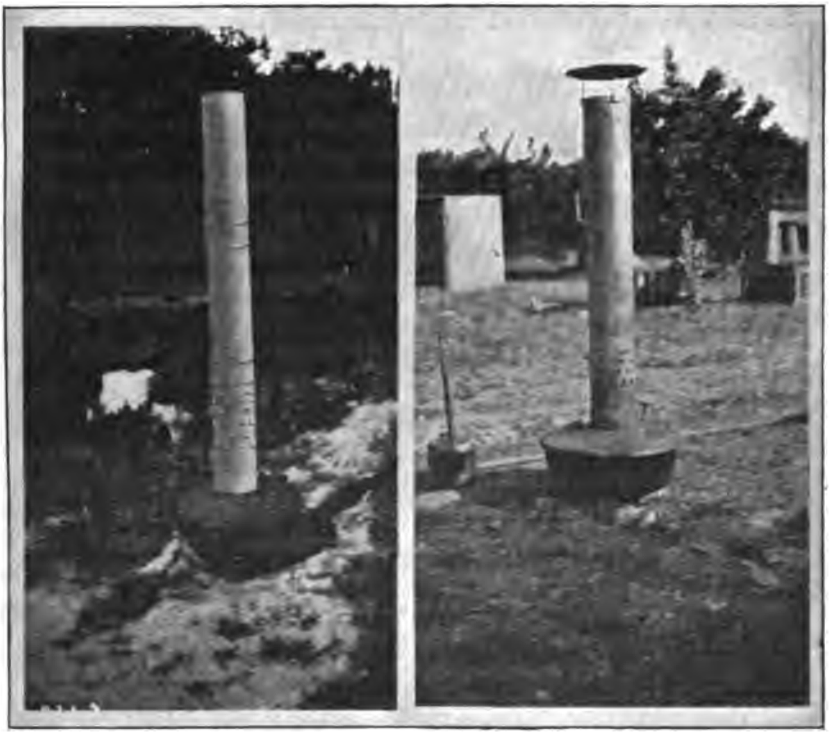


FIG. 7.—Two types of high-stack oil heaters. Air is admitted through a draft opening in the cover of the bowl, supporting combustion at the surface of the oil. The hot gases then burn while rising through the stack, the necessary air being admitted through the perforations near the base. At the left of the heater on the right is shown a lighting torch of the type in most general use. It consists of an ordinary oil can with a long spout, into the end of which is inserted a wick of asbestos wrapped in small mesh wire screen. The lighting fluid is ignited while flowing through and around the wick and falls in flaming drops.

depends on the distance from the heater. With increasing distance the radiation intercepted decreases very rapidly.

Experiments conducted by Prof. H. H. Kimball show that when the high-stack heater is burning at a moderate rate with only the lower section of stack red-hot, the heat radiated directly to the tree is sufficient to counterbalance outgoing radiation at a distance of 10 feet. When the entire stack is red-hot the outgoing radiation will be counterbalanced at a distance of about 15 feet.

With the short stack and lard-pail heaters radiation is not of so much importance unless the plants to be protected are very near the heater.

A large percentage of the radiant heat given off by an orchard heater is lost directly to the sky without appreciable effect on the temperature of the air or of the plants. As radiant heat travels in straight lines and is completely absorbed or reflected by fruit and leaves, any fruit shaded from the heaters by leaves or branches can receive practically no direct benefit from the radiated heat. It is plain, therefore, that to obtain the greatest amount of protection from the same amount of fuel, heaters which are most efficient in raising the temperature of the air should be used if possible, rather than those which radiate most of their heat and are not so effective in raising the temperature of the air.

Distribution of Heaters.—For the best distribution of the heat throughout the orchard it is better to have the heaters placed in every row, if possible, instead of concentrating them in every fourth or fifth row. This makes for a more general intermixing of the warmed air from the heaters with the cold air surrounding them. If rows of heaters some distance apart are lighted through an orchard on a calm morning, from the edge of the fired area it is possible to note "arches" in the smoke over the fired rows, with depressions in between. If the air is moving steadily from one direction, even slowly, the heat will be spread out and mixed so that this "chimney" effect will not occur, even if rows some distance apart are lighted.

In some parts of southern California, where the air drift is practically always continuous from the same direction during a cold night, firing along "check lines" is practiced. Mr. Willis S. Jones, of Claremont, Calif., is the originator of this plan and has had great success with it on his own 40-acre orange grove. His plan is as follows (see fig. 8):

The air movement in his grove is generally steady and is normally from the north. It sometimes shifts to the northeast and east, but practically never blows from a southerly or westerly direction. On the northern and eastern borders of the grove three short-stack citrus heaters are placed to each tree, and on the line immediately inside these heaters are placed one to a tree. The remainder of the orchard is divided into checks 16 trees square and a double row of heaters is distributed along each check line. The remainder of 3,800 heaters are placed one to each tree in the colder parts of the orchard and one to two trees in the remainder of the orchard.

When the time to fire arrives, the direction of the air drift is noted, and the outside row to windward is fired first so that the heat is carried into the orchard. (See fig. 9.) Three more east and west lines are fired immediately afterwards, and if the temperature continues to fall, three north and south lines are fired. The 40 acres are then divided into 16 checks of 256 trees each, surrounded on all sides except the extreme west and south by lines of fires 20 feet apart. If the temperature still remains low in the colder parts of the orchard,

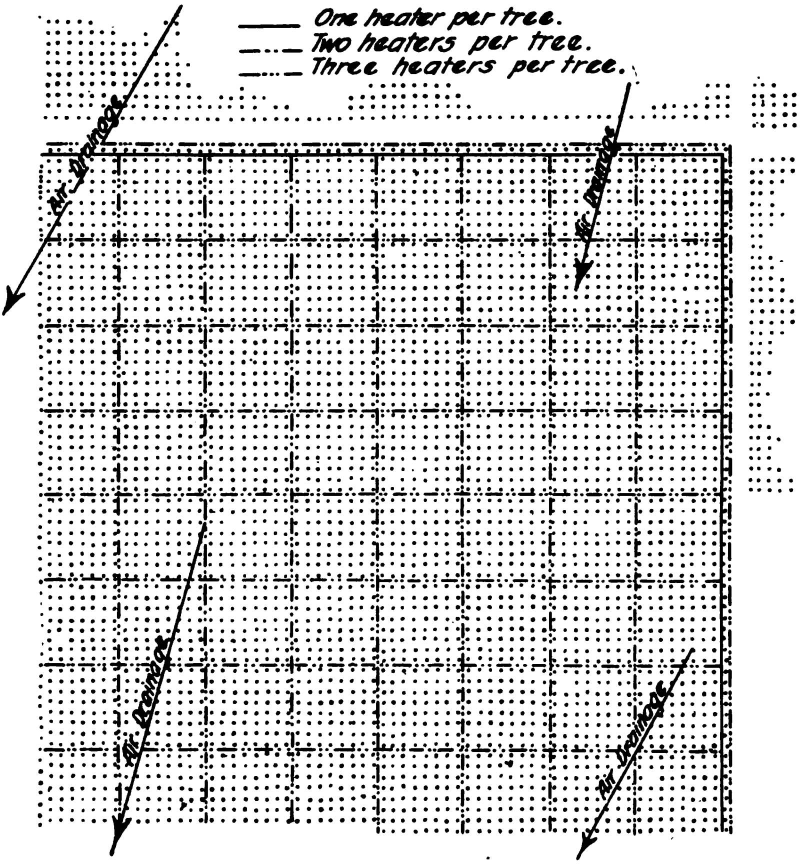


FIG. 8.—Diagram of 40-acre orange grove owned by Willis S. Jones, near Claremont, Calif., illustrating his system of firing orchard heaters along check lines. Dots represent orange trees, spaced 20 feet apart on the square. The normal direction of the air drift on cold nights is shown by the arrows.

the eighth rows east and west are fired. This has been necessary on only two occasions in four years. During the four seasons from 1914 to 1917, more than 580 heaters were never lighted at one time on the 40 acres. The heaters are burned at their maximum rate at all times. Mr. Jones advocates this system of firing on account of—

1. Easy and rapid lighting; one man can light 250 to 300 heaters per hour.
2. Easy and rapid refilling the next day.

The firing on the 40-acre grove is easily handled by two men.

In experiments carried on during the winter of 1918–19 in coöperation with the Pomona Valley Frost Protective Association and Mr. Jones it was found that the temperature 5 feet above the ground and 70 feet inside the two outside check rows can be raised from 2° to 4°. With several check rows across the line of drift burning it is probable the temperature at the leeward side of the orchard is raised a somewhat greater amount. In adopting this system of firing, the space between the check lines should contain at least one heater to every two trees for use in an emergency, when the fires on the check lines may fail to hold the temperature above the danger point.

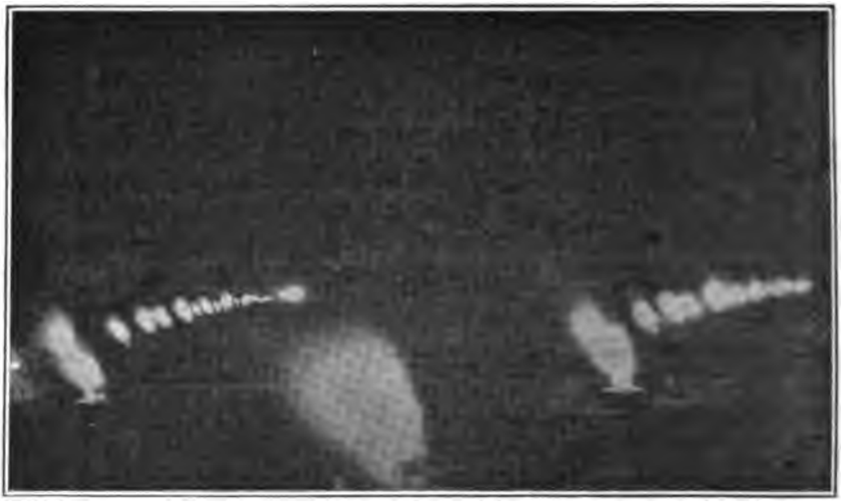


FIG. 9.—Outer check line of fires on the north of Willis S. Jones orchard, photographed about 3.30 a. m. on a cold morning. An exposure of about 15 minutes was required. The absence of any flame on the right (north) side of the heaters indicates the steadiness of the air drift.

The heated air from a fired orchard often drifts through neighboring orchards which are not fired, affording them in some cases even more protection than the fired orchard itself. (See figs. 10 and 11.)

Number of Heaters per Acre.—The number of heaters to the acre necessary for protection depends on the location of the orchard with regard to surrounding topography. For deciduous orchards in the colder sections there should be not less than 100 of the 5-quart lard-pail heaters to the acre, and if exceptional cold is likely to be experienced frequently, about 140 to the acre should be used. Of course all the heaters are practically never lighted at once; some are always held in reserve to be used when others burn out. In the warmer deciduous fruit regions, where the temperature is not likely to fall below 25° at any time, these heaters should be set about 80 to the acre.

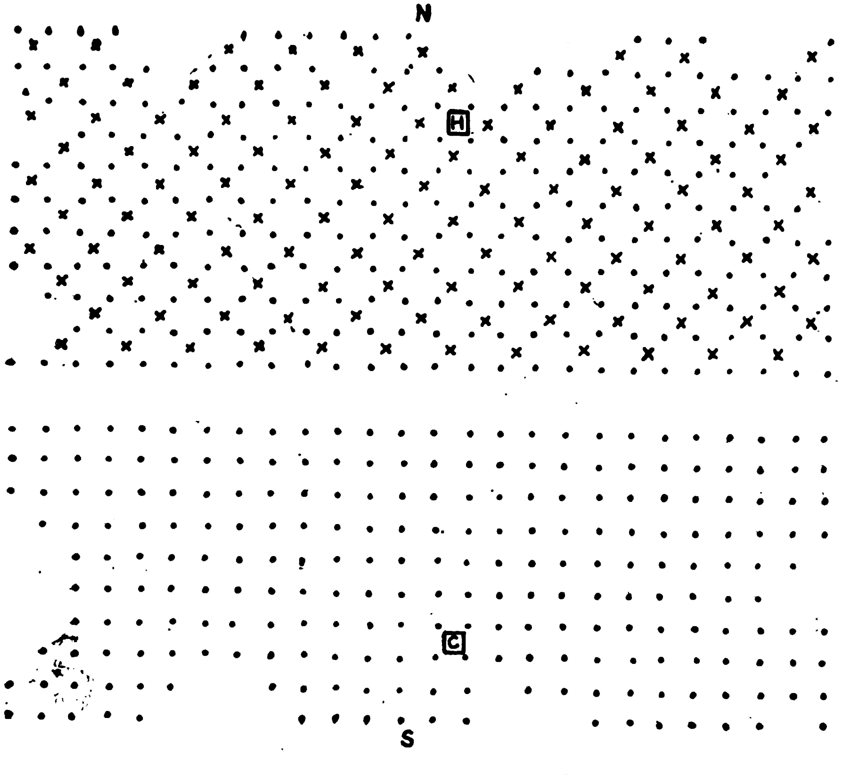


FIG. 10.—Plan of lemon groves where temperature records shown in figure 11 were obtained. Dots represent lemon trees, spaced 20 feet apart; crosses represent high-stack oil heaters. Squares marked H and C show locations of thermometers in heated and unheated groves, respectively.

The number should not be much less if 2-gallon lard-pail heaters are used. The larger heaters have a longer burning time, but the amount of heat released in a given time is not much greater. (See fig. 12.)

The number of the newer improved type of heater necessary for protection depends on the location of the orchard and on the kind of fruit to be protected. Orange groves on low ground, where temperatures as low as 20° may occur as often as every five or six years, should have at least one large capacity heater to each tree. On the higher slopes the number may be reduced to 80 per acre, but if extremely heavy frosts, like those of 1913 in California, are to be fought successfully, dependence should not be placed on a much smaller number. Some growers have successfully protected their orange crops for several years with as few as 30 or 40 heaters to the acre, but no exceptionally heavy frosts occurred during that time. (See figs. 13 and 14.)

Lemons are more susceptible to frost damage than oranges, but where a large acreage is protected it is usually possible to save the large fruit with 100 large capacity heaters to the acre when the temperature falls to 19°. A portion of the blossoms and young fruit is likely to be frozen when the temperature remains at this point for five or six hours, even with 100 heaters to the acre.

Care of Oil Heaters.—The amount of attention given to storage and care of oil heaters varies greatly in different parts of the country. In parts of California where the annual rainfall is light, many fruit growers leave the heaters in the orchards during the entire year, setting them up close to the trunks of the trees after the danger of frost is past. Trees are sometimes injured or even killed through oil from leaky heaters penetrating the soil around the roots. For this reason, heaters left in the orchard should be emptied at the end of the season. Lard-pail heaters are usually covered with a film of oil, which helps to prevent rusting, and the rate of deterioration is little, if any, greater than is the case when they are stored under cover. Where there is considerable annual rainfall, lard-pail heaters should be emptied, dipped in heavy oil, and stored under cover when not in use. With ordinary care heaters of this type will last 10 years or longer. Several orchardists have used them 14 and even 16 years without losing more than a small percentage through deteriora-

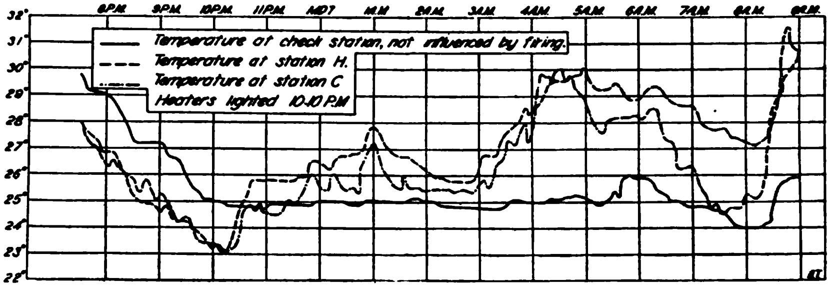


FIG. 11.—Continuous records of the temperature at stations H and C in figure 10 and at a third station located in an unheated orchard about 500 yards to the southeast. When the fires were lighted at station H about 10 p. m., the warmed air drifting across to station C raised the temperature there almost as much as at station H inside the fired area. At the end of the season the fruit at station C was in better condition than that at station H, due to the protection afforded by the firing in the neighboring grove. Note that the temperature at stations H and C ran nearly 2° lower than at the third station before the fires were lighted.

tion. Some fruit growers prevent contact between the bottoms of the heaters and the ground by placing the heaters on small square pieces of board.

The cost of the larger heaters is so great that it is good practice to give each one a coat of good stack paint at intervals of 2 or 3 years to prolong its life. Mr. Willis S. Jones, of Claremont, Calif., has his heaters thoroughly brushed with a steel brush to remove rust and dirt. Each heater is then placed on an iron grating under which one or two heaters are burning until it is brought to a high temperature, after which the paint is applied hot.

At the end of each season the heaters usually contain a small quantity of a mixture of soot and asphaltum, which sticks to the bottom and is difficult to remove when cold. The usual method of removing this material has been to burn it out with distillate. In doing this accidents often occur and piles of several hundred or more heaters sometimes catch fire, ruining the heaters and endangering surrounding property.

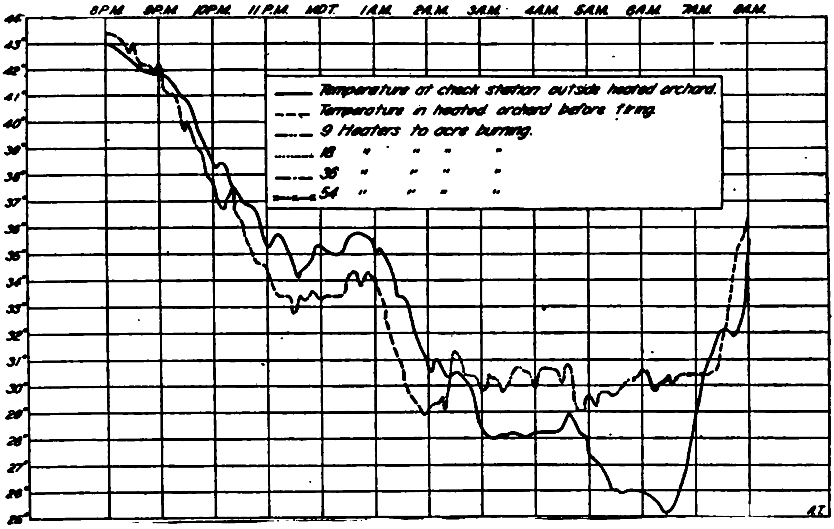


FIG. 12.—Continuous records of the temperature inside and outside a heated pear orchard, showing the effect of the firing on the temperature. Five-quart lard-pail oil heaters were used. Note that the temperature in the heated orchard ran about 2° lower than at the check station before the heaters were lighted.

At the Bear Creek Orchard, Medford, Oreg., the manager, Mr. B. B. Lowry, has a trench covered with sheet iron on which he treats the empty heaters at the end of the season. A fire is built under the iron, using the residue from the heaters for fuel, which burns fiercely. A large inclined flue carries away the smoke from the fire and creates a draft. The heaters, a dozen at a time, are placed on the sheet iron until they become hot and the residue is loosened, when they are removed with tongs one by one and rapped against a post, causing the residue to fall out. They are then examined for leaks by holding them upward toward the sun. The work can be handled very rapidly in this way and there is little danger of accident.

Coal Heaters.—Coal is burned in open piles on the ground, in wire baskets and in specially designed sheet-iron heaters. Coal heaters possess some advantages over oil heaters in that the heat can be applied near the ground, there is no strong up-draft and usually not much soot or smoke after the first few minutes of burning. On the other hand, coal fires are often difficult to light and hard to regulate; the fires often have a tendency to smolder slowly or burn out with a rush. When firing is required for several hours it is necessary to replenish the fuel in the heaters. The labor costs are relatively high, as a large number of men are required to attend to this work. In California reserve supplies of coal for each heater are kept in wooden boxes set under the trees. At the end of the season the heaters are placed on top of these boxes and are left out all the year.

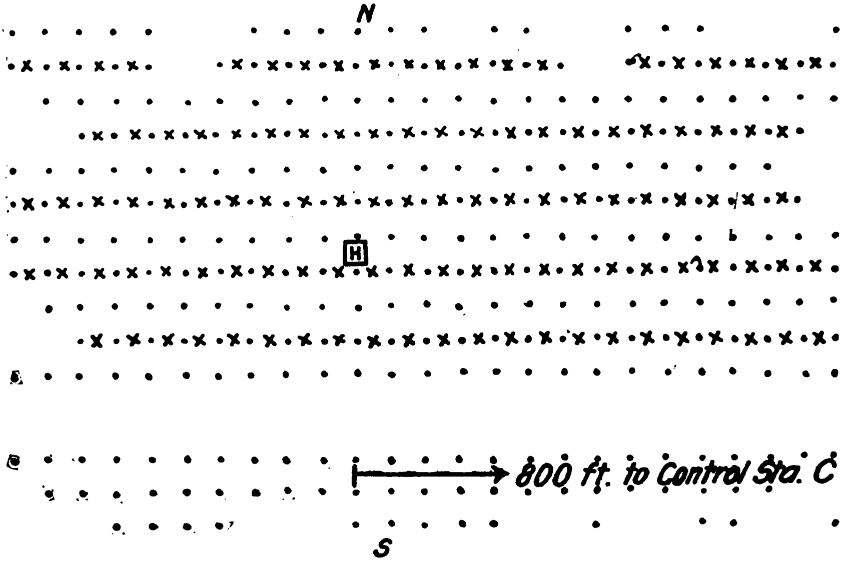


FIG. 13.—Plan of orange grove where temperature records shown in figure 14 were obtained. Dots represent orange trees spaced 20 feet apart; crosses represent low-stack oil heaters. The square marked H shows location of thermometers in fired orchard. The check station was located about 800 feet to the eastward to avoid the influence of the fires. The air drift on cold nights was normally from a northerly direction.

The number of coal fires to the acre should be about the same as when the lard-pail oil heaters are used.

Lighting Equipment.—Orchard heaters of all kinds can be lighted easily and rapidly with torches burning a mixture of gasoline and distillate or gasoline and fuel oil. (See fig. 7.) These torches drop the burning liquid into the heaters, starting combustion immediately. Lard-pail heaters when new are sometimes difficult to light. If the burning liquid from the torch is poured in a ring on the edge of the heater, no difficulty will be experienced. After three or four firings the carbon deposited on the rim of the heater acts as a wick and a little burning liquid dropped anywhere in the oil will ignite it readily.

Many fruit-growers hire school boys to light the heaters and have been able to place great dependence on them.

Coal fires should be carefully built up with oil-soaked waste or paper and a small amount of kindling. If a portion of the fires fail to burn a great deal of valuable time is lost in going back over the same territory again.

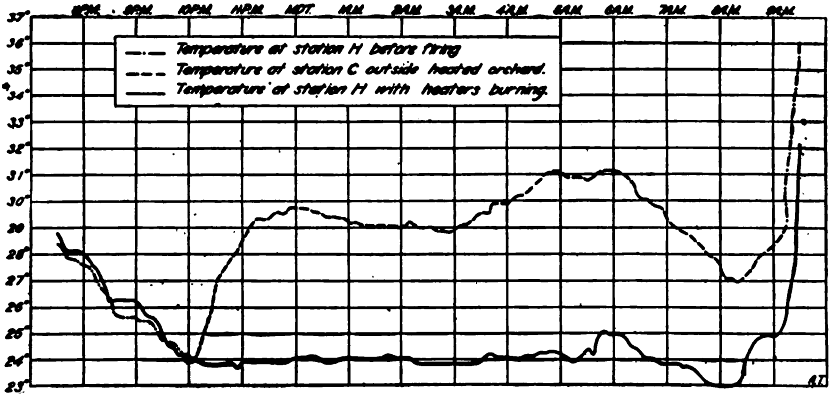


FIG. 14.—Continuous records of the temperature at stations shown in figure 13, showing the effect of firing on the temperature. Low-stack oil heaters of the type shown in figure 6 were used.

Storage of Fuel.—In order to carry on orchard heating successfully it is necessary to have enough fuel within reach to last through the longest cold spell likely to be experienced. Too many instances have been noted where the crop has been protected successfully through several cold nights at considerable expense, only to be lost on one cold night on account of lack of fuel. Where orchard heating is practiced by many growers in a community it is a good plan to buy and store large quantities of fuel oil on a cooperative basis, as is done in southern California. Orchards located near the storage tanks can haul directly from them, but in the case of those located a mile or more distant, storage tanks should be provided in the orchard.

The necessity of pumping oil from storage tanks should be avoided by raising the tanks high enough above the ground so that the oil will flow into the wagon tanks by gravity. Where the ground is not too flat, the storage tank can be so located that the oil can be put into it and taken out by gravity. If more than 5 acres are to be fired with oil a portable tank from which to fill the heaters is almost a necessity on account of the saving in time and labor. Three men with a tank wagon can fill heaters very rapidly, one man driving and two men drawing oil into 5-gallon buckets and pouring it into the heaters, filling two rows at the same time. The owners of two adjoining orchards often use the same tank wagon.

Owners of small orchards often handle the oil in metal drums of about 50 gallons capacity. The heaters are filled directly from the drums, which are hauled through the orchard on sleds.

IS ORCHARD HEATING PROFITABLE?

This question can be answered only by the individual grower, as the factors to be considered in drawing a conclusion vary greatly, sometimes even for orchards within a few miles of one another.

The most important points to be considered are as follows:

1. What has been the average loss from frost damage in your orchard during a period of years—as long a time as possible? Unless these data are available from personal experience they will usually be difficult, if not impossible, to obtain, although neighboring fruit growers may sometimes be able to supply some information. As a general rule, few records of this kind have been kept.
2. How many times during this period of years would it have been necessary to light the heaters in order to have saved the entire crop each year? If dependable temperature records have been kept for a number of years somewhere in the immediate vicinity and are still being kept at the same location, a comparison of records from the orchard and from the station with the long record for the same season may make it possible to gain a fairly accurate conception of what temperatures have been experienced at the orchard in question.
3. Will the value of the fruit lost through frost damage more than pay interest and depreciation charges on an investment for all necessary heating equipment, together with all costs of operation?
4. Is your locality likely to be visited by short periods of extremely cold weather during the growing season that may badly injure or kill the trees? This question can probably be determined from Weather Bureau records from some station in the vicinity.

There are two conditions under which orchard heating will not be profitable. The orchard may be located where frost damage is too slight in the long run to pay the expenses of heating, or the orchard may be in an exceptionally cold section where damaging frosts occur so often that the costs of protection are too great to be borne by the crops.

The number of cases of the first-mentioned type is smaller than would appear at first thought. The saving of one season's crop, which would otherwise have been a total loss, will justify the expense of heating for a good many years. Some practical growers consider it good business policy to have frost-fighting equipment, even though it is necessary to use it only one season out of five.

In cases of the second type it is obvious that the frost hazard is so great that fruit growing will not be profitable in the long run and the trees will eventually have to be removed.

The statement is often made that the policy of growing fruit on the colder low ground is wrong and that orchards should be confined to the higher and more frost-free locations. This is not always true. In some parts of southern California the difference in the cost of irrigation more than makes up for the expense of protecting the orchards on the lower ground from frost. In addition to this the cost of cultivating steep hillsides is greater. The same is true of certain deciduous fruit districts in Oregon.

On a farm near San Francisco potatoes have been grown successfully during the winter months for several years with the aid of open lard-pail oil heaters. Irrigation water necessary for crops grown during the summer is scarce and expensive, while the rainfall during the winter months is ample. The new crop is harvested in the spring, and reaches the market so early that exceptionally good prices are obtained.

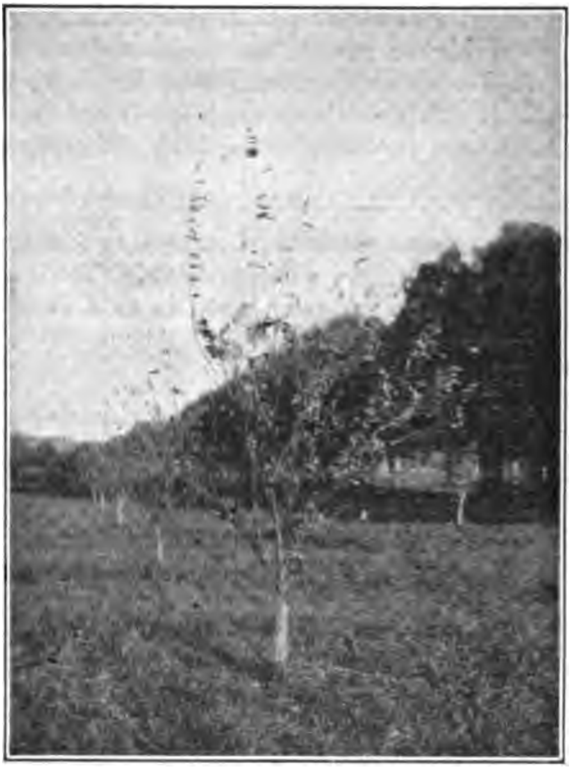


FIG. 15.—Young lemon tree almost entirely stripped of foliage by frost. The fruit was a total loss and most of the the remaining leaves dropped later.

The degree of success attained in protecting potatoes at this place indicates that low-lying crops may be protected against ordinary spring frosts by using the small open lard-pail heaters, set from 60 to 80 to the acre. In addition to the heating of the air over the plants, the direct radiation of heat from the heaters aids considerably in protecting the plants immediately surrounding them. In planting a field to a low-growing crop that is to be protected with heaters, vacant spaces about 18 inches square should be left at the points where the heaters are to be placed, as the plants very close to the heaters are likely to be scorched.

Orchard heating has been practiced for six years on one of the largest lemon groves in the country, located in southern California. During the season of 1912–13, a season when the citrus crop in many parts of southern California was practically a total loss and thousands of trees were killed outright, the lemon crop from this grove brought $734,318.07 f. o. b. California.

On higher ground on the same ranch 5-year-old lemon trees which were not protected were frozen to the ground. The manager of this ranch states it is his belief that the business would not have been profitable since 1912 without means of protection from frost.

MAXIMUM COST OF FIRING

Records on the cost of protecting 220 acres on this place during the past six years are shown below. (Table 1.) It will be seen that the returns from the fruit saved in 1913 alone would pay the costs of protection for many years. About 500 acres of lemons are now being protected here.

TABLE 1.—*Average cost per acre for protecting 220 acres of lemons with oil heaters.*[1]

	Year.						Total 6-year average, per acre.
	1913	1914	1915	1916	1917	1918	
Labor, man and horse, filling and lighting pots, per acre	$45.70	$10.55	$10.65	$21.45	$20.60	$22.15	$21.85
Oil	38.35	12.70	4.20	23.20	26.15	17.75	19.55
Depreciation	19.30	19.10	17.40	15.60	14.30	13.00	16.45
Interest	17.85	17.45	15.50	13.40	13.45	11.25	14.80
Upkeep	11.55	7.95	7.65	1.10	5.65	3.70	6.25
Total	132.75	67.75	55.40	74.75	80.15	67.85	78.90
Number of times fired	19	2	7	20	27	21	

[1] Small open heaters used in 1913; down-draft, short stack type in later seasons.

This ranch is located on both high and low ground, but only the low ground is protected. Lemons are more easily damaged than oranges, and as the small green fruit is protected here, the fires are lighted oftener than in most other orchards. The costs given above are for firing about the maximum number of times that would be necessary anywhere in the country.

AVERAGE COST OF FIRING

Mr. Willis S. Jones, of Claremont, Calif., has kept accurate records on the cost of firing his 40-acre orange grove, which is on rather high ground and is fired only a few nights each year as a general rule. These cost figures, given below (Table 2), are for firing a number of times per year which is probably slightly below the average.

It is impossible to estimate present-day costs of equipping an orchard from any of the above figures on account of the increase in the price of all materials used in the manufacture of heaters and other equipment.

Mr. Jones's orchard was not equipped with heaters in 1913 and his crop was a total loss. At the prices prevailing at that time he estimates he lost fully $10,000 worth of fruit in the two seasons prior to 1913, and $25,000 worth of fruit in 1913. In addition, so many of his trees were severely damaged that he experienced a heavy loss in reduced crops during the next several years. Since putting in heating equipment, including the severe season of 1918–19, his losses from frost damage have been negligible.

TABLE 2.—*Detailed costs of protecting 40 acres of oranges with oil heaters.*

EQUIPMENT INSTALLED NOVEMBER AND DECEMBER, 1913.

Storage:		
21,000-gallon galvanized iron tank	$298.90	
Concrete foundation	45.92	
Pipe line	164.46	
Laying pipe line	7.85	
		$517.13
Distributing system:		
Wagon	51.50	
Two 575-gallon tanks, complete	161.70	
4 buckets	6.20	
1 dozen lighting torches	9.00	
		228.40
Heaters:		
3,800 heaters at $0.58	2,204.00	
Painting heaters at $0.02	76.00	
		2,280.00
Thermometers	42.00	
		42.00
Total investment		3,067.00

OPERATING EXPENSES.

Interest:			
6 per cent on $3,067, original cost			$182.85
Depreciation:			
Storage tank, 5 per cent on $298.90	$14.93		
Pipe line, 3 per cent on $164.46	4.93		
Wagon, 10 per cent on $51.15	5.15		
Wagon tanks, 8 per cent on $161.70	12.93		
Buckets and torches, 20 per cent on $15.20	3.04		
Heaters, 12½ per cent on $2,204	275.50		
Thermometers, 5 per cent on $42	2.10		
			318.58
Operation:			
Oil, 1913, 25,095 gallons at $0.03	752.85		
Hauling, at $1.50 per 1,000	37.63		
		$790.48	

TABLE 2.—*Detailed costs of protecting 40 acres of oranges with oil heaters*—Con.

OPERATING EXPENSES—Continued.

Operation—Continued.			
Oil, 1914, 13,725 gallons at $0.03	$401.75		
Hauling, at $1.50 per 1,000	20.58		
		$422.33	
Oil, 1915, 575 gallons at $0.03	17.25		
Hauling, at $1.50 per 1,000	.75		
		18.00	
Oil, 1916, 15,525 gallons at $0.04	621.00		
Hauling, at $1.50 per 1,000	23.28		
		644.28	
Total for four years		1,875.09	
Credit oil on hand, 17,173 gallons, at $0.04	686.92		
Hauling, at $1.50 per 1,000	25.75		
		712.67	
Net cost, 4 years		1,162.42	
Average cost per year			$290.60
Distributing, filling, firing, taking in, cleaning, and painting heaters:			
1913–14		199.88	
1914–15		204.63	
1915–16		340.90	
1916–17		336.70	
Total cost for four years		1,082.11	
Average cost per year			270.52
Total annual cost for 40 acres			1,062.55
Average annual cost per acre			26.56

Detailed average annual cost per acre.

Interest	$4.57	
Depreciation	7.96	
Operation:		
Fuel	7.26	
Labor	6.76	
		$26.55

BEST METHODS OF HANDLING ORCHARD HEATING

The fact can not be emphasized too strongly that if orchard heating is to be practiced successfully, it must be handled with as much care and attention as spraying, fumigating, or any other necessary farm work. The secret of success will be found in adequate equipment, good judgment, attention to detail, and extreme vigilance. An inadequate number of fires to the acre may often be worse than none at all, as the costs of firing may have to be added to the loss of the crop.

Whenever the temperature approaches the danger point the thermometer *in the orchard* should be watched closely and, if possible, the rate at which the temperature is falling should be determined. If the temperature is falling rapidly the firing must be begun early if the heaters are to be all lighted before the danger point is reached. With a little practice it is often possible to tell with considerable accuracy by inspection of the fruit or blossoms, when the danger point has been reached, regardless of the temperature.

When small apples or pears commence to freeze minute blisters will begin to form on the skin. By keeping constantly on the watch for the first appearance of these blisters on the fruit in the coldest part of the orchard, the firing can be begun at exactly the right time; no fruit will be lost and no oil wasted. By carefully cutting the blossoms of deciduous fruit it is generally possible to note with ice crystals first begin to form in them, and thus regulate the beginning of firing.

When oranges begin to freeze, the section of the skin exposed to the sky takes on a transparent appearance, generally known as the "water-mark," probably caused by the water in the rind freezing and leaving the oil separated. On the following day these oranges can be picked out easily and are called "shiners." By timing the firing with the first appearance of the "water-mark" in the orchard, it is possible to save the fruit and yet prevent waste of oil. Some experience is necessary before the fruit grower is able to use these methods of timing the firing; but the importance of saving oil is well worth giving the matter close attention.

If the small lard-pail heaters are set 100 to the acre, alternate heaters in every fourth row should be lighted first, followed immediately by alternate heaters in every second row if the temperature has been falling rapidly. The effect on the temperature should then be noted and decision made as to whether additional firing is necessary at that time. As soon as a row of heaters begins to burn low, reserve heaters should be lighted, as the amount of heat given off during the last half hour of burning is small.

If the large capacity down-draft heaters are used, all may be lighted at once if desired and the consumption of oil regulated by manipulating the drafts.

During a cold night an isolated cloud passing overhead, by cutting off radiation and to a certain extent reflecting radiation from the earth, may cause the temperature to rise. As the cloud drifts toward the horizon the temperature falls again. Likewise, sudden temporary rises in temperature are caused by gusts of wind of short duration which mix the upper and the surface air. As a general rule the temperature falls rapidly after the wind or cloud has passed and cases are on record where entire crops were lost through extinguishing the heaters at such a time. If clouds are overspreading the whole sky or a sudden rise in temperature due to wind occurs just before sunrise, the heaters may be extinguished, but if the sky remains clear and sunrise is an hour or more away, the temperature should be watched closely during the remainder of the night.

Although it is sometimes difficult to find time to keep records on heating operations during the rush of firing, it should be done whenever possible. The temperature when firing is begun, time of initial firing and number of heaters fired, time of firing additional heaters, the lowest temperature recorded during the night, can all be jotted down from time to time as the work goes on. On the following day an estimate can be made of the amount of oil consumed and the extent of the damage to the fruit, if any. Records of this kind will be found to be of great value in regulating later firing; the more information of this kind gathered, the more efficiently can the firing be handled. Records of this kind will also help to determine whether protection is profitable or not, a question which every grower should solve for himself at the earliest possible time.

If orchard heating is carried on in a careful, painstaking manner, with ample equipment, there are probably few commercial fruitgrowing districts where the heaviest frost likely to be experienced can not be successfully fought with orchard heaters.

FROST AND MINIMUM TEMPERATURE FORECASTS

General forecasts of frost for large areas are issued by the Weather Bureau during the growing season, and in certain rather small districts where protection against frost damage is practiced on a large scale, forecasts of the minimum temperature to be expected from night to night are issued. Farmers or fruitgrowers who have a means of protecting their crops should arrange with the nearest Weather Bureau station to obtain forecasts of the kind available in their community.

INJURIOUS TEMPERATURES

So many factors must be taken into consideration in determining whether a given temperature will cause damage that the matter is one of great complexity. The length of time the low temperature persists, the vigor and stage of advancement of the plant, the kind of weather preceding the frost, and the rate of thawing all have considerable influence on the amount of damage that will be done. Other conditions being the same, a weak, undernourished plant will show more injury than a strong healthy one after both have been subjected to the same low temperature.

Pure water has a higher freezing point than water carrying foreign substances in solution. For example, the freezing point of a strong solution of common salt may be 23° or lower, depending on the concentration; the weaker the solution the higher the freezing point. When the weather is warm and sunshine and moisture plentiful, plants make a rapid growth and the sap is likely to be watery and its freezing point high. For this reason a frost which follows a period of weather favorable for rapid growth will cause more damage than the same frost following a period of cold cloudy weather and consequent slow growth.

When a plant freezes a portion of the cell sap is withdrawn from the plant cells, gathering in the intercellular spaces in the form of ice. If thawing takes place gradually and the cell walls have not been ruptured, this moisture is again taken up by the cells as it is melted, without serious damage. If thawing takes place rapidly, however, the intercellular ice is liquefied faster than it can be absorbed by the cells; a part of it is lost by evaporation and the cells are broken down. When fruit crops are damaged by frost the greatest damage is often found on the portion of the tree where the morning sun strikes first. When clouds gather on the eastern horizon before sunrise and obscure the sun for a few hours in the morning after a cold night, damage to vegetation is likely to be slight, provided the temperature does not fall much below the critical temperature. Heavy smoke from orchard heaters or smudge fires may also lessen damage from frost through causing a slow thawing. Of course, if the temperature falls sufficiently low a great deal of damage may be done even when the rate of thawing is slow; in other words, the prevention of a rapid rise in temperature in the morning may often not be sufficient in itself to prevent injury.

It is possible that some of the protection from frost damage obtained by irrigating is due to making available to the damaged plant cells a larger supply of water through increased flow of sap, to replace that lost through freezing.

INFLUENCE OF HUMIDITY ON RATE OF FREEZING

Fruit growers in nearly all sections are convinced that with the same temperature the amount of damage by frost will be greater when the humidity is low than when it is high. Recent studies by I. G. McBeth, of the Leffingwell Rancho at Whittier, Calif., indicate that under certain conditions citrus fruits will be damaged in a shorter time when the humidity is high than when it is low, the temperature being the same in both instances. It was thought this was due to greater conductivity of moist air, the heat being conducted away from the fruit more rapidly, causing the temperature of the fruit to fall more nearly at the rate at which the temperature of the air was falling.

However, in making these investigations allowance was not made for the influences of radiation and the liberation of heat by condensation. Under orchard conditions, blossoms and leaves exposed to the sky lose their heat rapidly by radiation and their temperature may fall several degrees below that of the surrounding air. The temperature of mature citrus fruits falls more slowly than that of the surrounding air but the rate of fall follows more closely that of the outside air when radiation is rapid than when it is slow. Growers of citrus fruits are familiar with the fact that the first fruit to be damaged is that which is exposed to the sky; fruit on the interior of the tree and screened from the sky by leaves or branches often will show no injury with air temperatures several degrees lower. Radiation goes on more rapidly when the air is relatively dry than when it is moist and the temperature of the fruit is likely to follow more nearly that of the surrounding air when the humidity is low.

On nights when the humidity is high, considerable ice is deposited on the fruit or blossoms. When this moisture condenses and freezes, some of the latent heat liberated tends to retard the rate of fall in temperature of the fruit. After sunrise the thawing of the ice and evaporation of the resulting water retard the thawing to a slight extent and this has a tendency to lessen the damage.

It is possible that under actual orchard conditions, these influences which tend to lessen the amount of damage on a night with relatively high humidity more than counteract the influence of the increased conductivity of the moist air.

DECIDUOUS FRUITS

Damage by frost to deciduous fruits usually takes place in the spring when the trees are in bud or blossom or shortly after the fruit has set. The stage of advancement is of the greatest importance in estimating resistance to low temperature; the same degree of frost that causes little or no damage to fruit in bud, may injure the greater portion of the crop two or three days later.

In the case of most deciduous fruits, the same temperature will cause far more permanent damage after the fruit has set than during the period when the trees are in full bloom, and the later the frost after the fruit has set, the greater is the actual loss. This is due to the fact that there is nearly always a great overproduction of bloom and usually from 50 to 90 per cent of the blossoms can be killed without materially reducing the final crop of fruit. This fact often causes orchardists to overestimate the amount of damage to their crops early in the season. One or two uninjured blossoms in each cluster are usually enough for a good crop. With some small fruits and nuts a larger percentage of the blossoms must mature in order to obtain a full crop and damage during full bloom is more serious.

Another point to be considered is the fact that the blossoms do not all open at once; there are often unopened buds and small fruits on the trees at the same time. Even though a heavy frost at this stage may kill all or most of the more advanced blossoms, there may still be a sufficient number of unopened buds left to insure a crop of nearly normal size. However, fruit from late bloom is usually undersized and of poor quality.

In the process of natural thinning the number of fruits on the trees is steadily and rapidly reduced after the period of full bloom and the loss of a large percentage of the fruit retained on the tree at this time is likely to reduce seriously the size of the crop harvested.

It is obvious from the above that the greatest need for protection comes after the period of full bloom. While a single night's frost during the period of full bloom may not seriously reduce the size of the final crop of apples, peaches, apricots, or pears, when the amount of bloom is reasonably heavy, each one of a series of heavy frosts at this period may kill a certain portion of the remaining uninjured blossoms, until not enough sound blossoms are left to make a full crop. Where an orchard is equipped with heating devices the only safe policy is to hold the temperature high enough at all times so that only a few blossoms will be injured.

Apples and pears are often badly injured by frost but remain on the trees and mature. Such fruits are mis-shapen and more or less seedless and are not marketable as first grade. Frosted pears enlarge abnormally near the stem and lose their characteristic pear shape, while injured apples become rough and their shape irregular. Injured fruit of this kind often remains on the trees until a month before maturity and then drops.

The blackening of the centers of blossoms or of small apples and pears does not necessarily mean that they will not mature, though the chances are greatly in favor of their dropping before the end of the season. The injured tissue is often gradually absorbed until the blackening entirely disappears.

Different varieties of the same fruit often differ considerably in degree of resistance to frost damage and when the same critical temperature is given for all varieties, it is applicable only in a very general way. The best possible arrangement to be followed by the orchardist who protects his orchard is to keep in touch with the local county agricultural agent or horticultural commissioner as the season progresses and obtain opinions from him from time to time as to the temperatures that will cause damage. These officials are likely to have had considerable experience in noting the effect of low temperature in the local district and are also familiar with the condition of the fruit or blossoms as they have been affected by previous weather conditions.

It will pay the individual grower to keep careful records of the temperature in his orchard on cold nights, together with notes on the effect on the size of the final crop. After a few seasons, he will have collected enough data to enable him to know with considerable accuracy how low it is safe to allow the temperature to fall before lighting the heaters.

The following table of critical temperatures as recorded by a well exposed thermometer in the orchard is meant to give a general idea of what the blossoms will endure for a half hour or less without injury.

Temperatures endured by blossoms for 30 minutes or less.

Fruit.	Closed but showing color.	Full bloom.	After fruit has set.
	°F.	°F.	°F.
Apples	25	28	29
Peaches	25	26	28
Cherries	25	28	30
Pears	[1] 25	28	30
Plums	25	28	30
Apricots	25	27	30
Prunes	28	29	30
Almonds	26	27	30
Grapes	30	31	31

[1] Bosc 27.

CITRUS FRUITS.

Owing to the lateness of the blossoming period of most varieties of oranges, the fruit has practically reached maturity before the frost season arrives in the subtropical sections where they are grown commercially. In this case, therefore, we have to deal with the chilling of a relatively large bulk in comparison with deciduous fruit or blossoms.

The thick pithy rind of the orange is a poor conductor of heat and the protection it affords causes the temperature of the interior to fall much more slowly than the temperature of the outside air. When the air temperature is falling rapidly the interior of the fruit may be as much as 7° warmer than the air surrounding it, and the temperature inside the fruit lags from an hour to an hour and a half behind the temperature of the air. As the freezing point of orange juice is about 28° F., the temperature inside the fruit will not fall much below this point until the fruit is frozen. (See fig. 16.) It is characteristic of any liquid that in the freezing process sufficient latent heat is given off to maintain the temperature at the freezing point of the liquid until the whole quantity of liquid has been frozen.

Radiation is of great importance in damaging citrus fruit and the fruit exposed to the sky is always the first to be frozen. It is probable that any beneficial effects that may be obtained by covering an orchard or tree are due in a large degree to diminishing the rate of

radiation from the fruit so that the fall in temperature inside the fruit lags considerably behind that of the air.

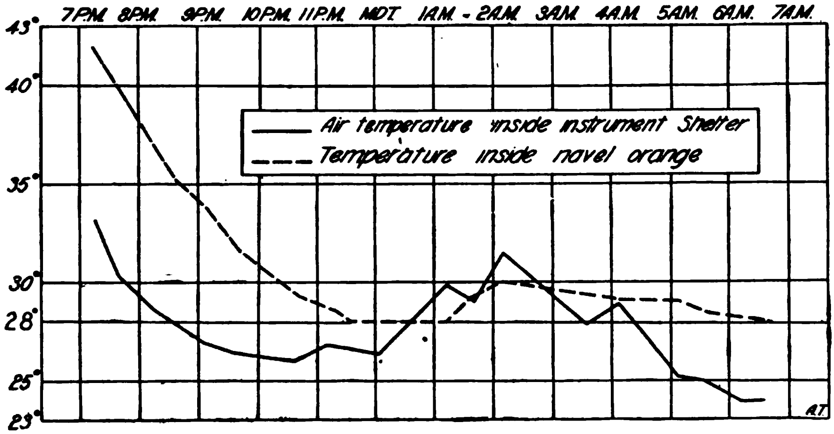


Fig. 16.—Eye readings of the temperature inside a 3½-inch mature navel orange on the tree exposed to the sky, compared with simultaneous readings of the air temperature inside a standard thermometer shelter at the same height above the ground. Note that the temperature inside the fruit did not fall below 28°, which is approximately the freezing point of the juice.

The critical temperature for nearly ripe oranges is most often given as 26° F. to 27° F. During the winter of 1918–19, however, two navel orange groves in southern California experienced air temperatures on different nights as shown in figure 17.

Comparative figures on the amount of damage in the two groves are given below:

Comparison of damage to two groves.

	Grove No. 1.		Grove No. 2.	
	Pounds.	Per cent.	Pounds.	Per cent.
Total fruit harvested	190,975	....	188,230	....
Extra choice	123,075	64	86,800	46
Choice	58,585	31	35,935	19
Partly frozen [1]	0	0	55,170	29
Culls (all sources)[2]	9,315	5	10,325	6
Eliminated (frozen fruit)[3]	0	0	5,400	3

[1] Fruit with up to 15 per cent of tissue 15 per cent frozen marketed in this grade, which brought from 40 to 70 per cent of the price received for undamaged fruit.

[2] Includes misshapen fruit, frozen fruit, etc., total loss.

[3] More than 15 per cent of tissue 15 per cent frozen. This fruit is a total loss.

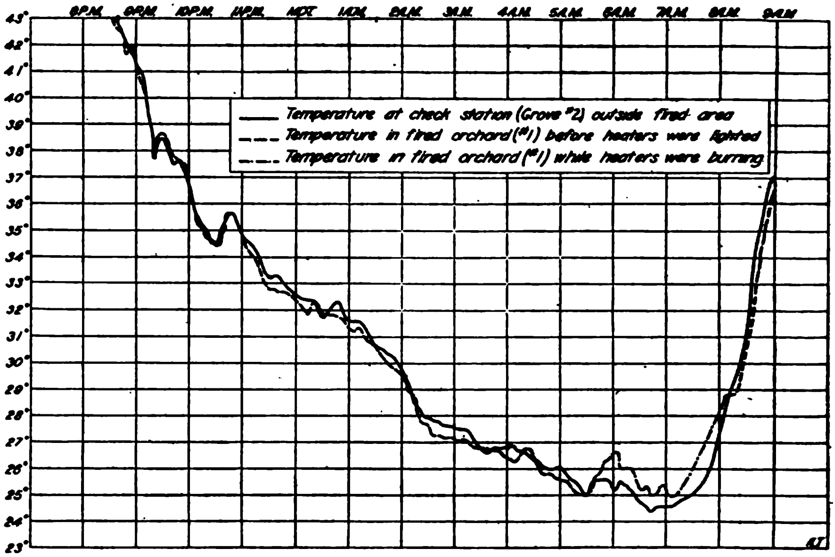
The fruit in grove No. 2 was of a much better quality before the first frost than that in grove No. 1, which accounts for the large amount of culls, not frozen, in grove No. 1. If there had been no damage from frost the amount of fruit marketed as "extra choice" and "choice" would have been much larger in grove No. 2 than in grove No. 1.

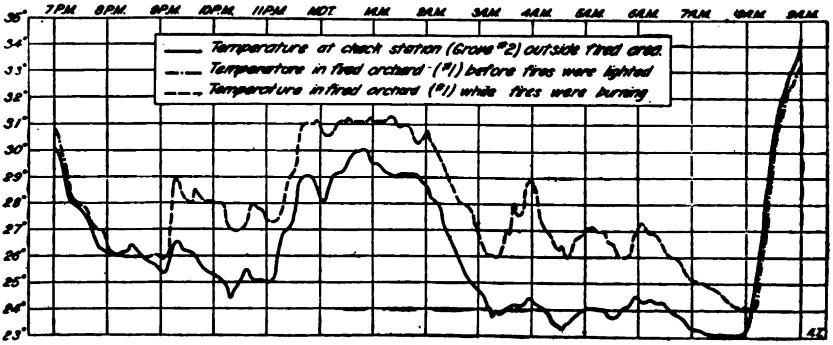
Green oranges are injured at considerably higher temperatures, their critical temperature being between 28° F. and 29° F.

Small green lemons are injured when the temperature remains at 29° F. for some time. Ripe lemons are damaged at 27° F. Lemon blossoms are killed at about 30° F.

METEOROLOGICAL INSTRUMENTS AND EXPOSURES

It has been stated that substances when exposed to a clear sky, steadily lose heat by radiation. Not only does the rate at which radiation takes place vary greatly on different nights, but every individual substance has its own rate at which it radiates heat. Therefore, under conditions favorable for radiation, a thermometer of dark metal would show a lower temperature than one of mercury inclosed in glass.





The only method whereby temperature measurements which are at all comparable can be secured is to obtain, not the temperature of the thermometer under radiation conditions, but as nearly as possible the temperature of the free air surrounding the thermometer.

We have seen that a relatively large amount of heat is required to change liquid water to water vapor. Evaporation is going on at all times, even when the air is saturated, although when saturation has been reached, the condensation of vapor balances the evaporation. Evaporation also takes place directly from ice. When a thermometer is covered with a film of water or ice, or contains frost on the bulb,

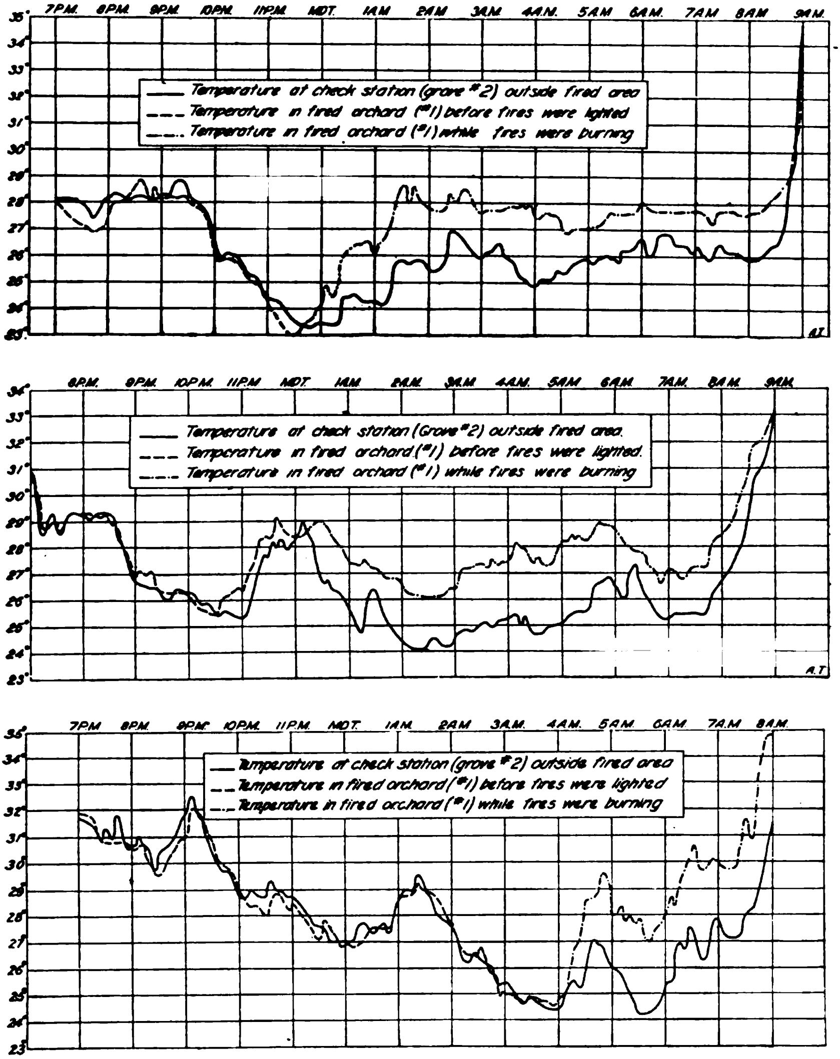


FIG. 17.—Continuous records of the air temperature inside standard instrument shelters in the two orange groves for which the comparative yields are given above. The grove at station C was not protected. The grove at station II was partially protected with coal heaters, set 50 to the acre. Station II was located in a row which contained no heaters and the temperature was probably somewhat higher in the rows containing heaters while firing was in progress. Note that the temperature fell as low as 23° for a short time, without any permanent injury to the fruit. As the weather had been cold for some time before these low temperatures occurred, however, the trees and fruit were considerably more resistant to cold than usual.

the evaporation that is taking place absorbs heat from the thermometer and cools it to below the temperature of the air. The amount of cooling depends on the amount of moisture in the air and on the rate at which the air is moving past the thermometer.

It is plain that if a thermometer is to register the temperature of the air, it must be sheltered from the sky and from direct sunlight, and also must be exposed in such a way that moisture from any source is not likely to gather on it.

Free circulation of the air is also an important requirement for a satisfactory thermometer exposure. If a shelter offers much obstruction to air circulation the air inside the shelter may cool at a slower or faster rate than the outside air and the thermometer in the shelter will then fail to indicate the true temperature of the outside air. It is essential, therefore, that a thermometer shelter allow as free a circulation of the air as possible without sacrificing the elements of protection from sunlight and liquid or frozen moisture. The standard Weather Bureau shelter has a double roof to prevent undue warming of the inside air by the sun's rays, and the bottom is as open as possible. The sides are louvred, the openings being as wide as possible without allowing the direct sunlight to reach the interior. (See fig. 18.)

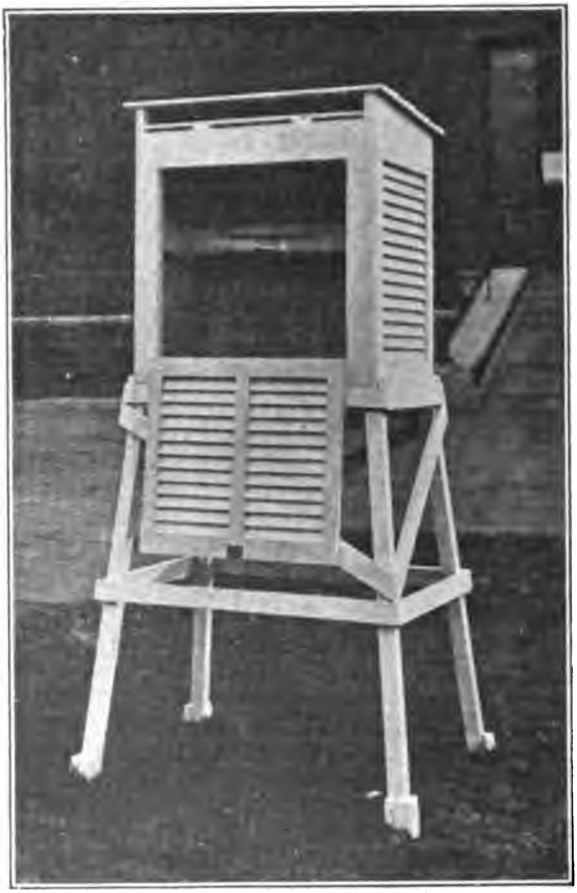


FIG. 18.—Standard type of instrument shelter used by the Weather Bureau. The shelter is always placed so that the door opens toward the north so that the sun can not shine directly on the instruments when the door is open.

All thermometers used in determining temperatures in orchards should be exposed with the foregoing principles in mind. A simple but fairly satisfactory method of sheltering a thermometer which is used only at night is to place a large thin flat board horizontally directly above it. The thermometer should be placed close up under the board so as to cut off as much of the sky as possible.

In reading a thermometer on a cold night, care should be taken not to breathe directly on it. Whenever possible, an electric flash-light should be used in making readings. When matches or candles are used to illuminate the thermometer, the temperature may be raised a degree or more before the reading can be made, which may in some cases results in loss of fruit through not lighting the heaters in time.

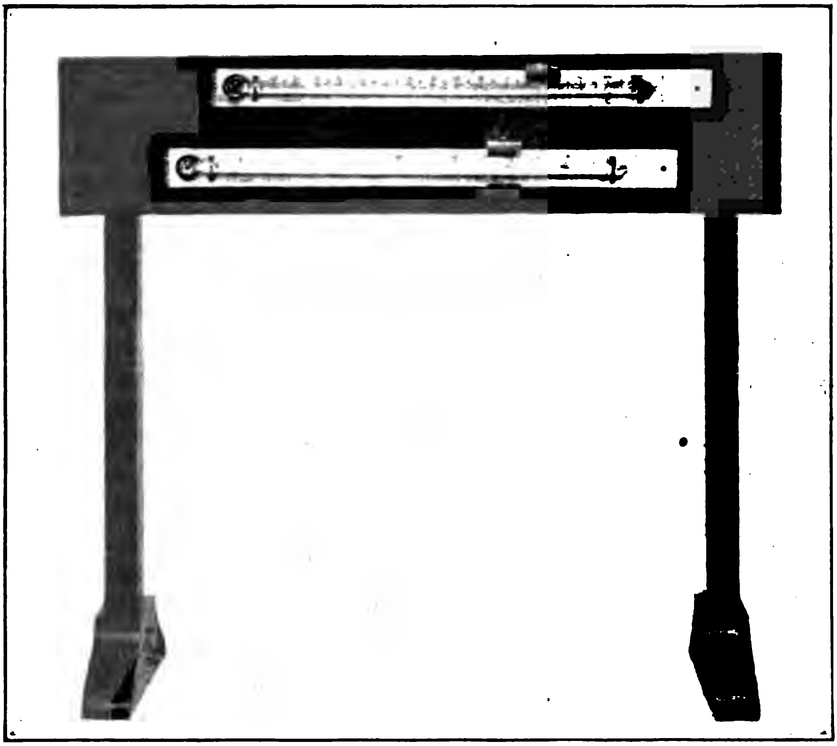


FIG. 19.—Types of thermometers used by the Weather Bureau to register the highest and lowest temperature.

Every orchardist who has frost-fighting equipment should have at least one accurate dependable thermometer to be placed in the coldest part of the orchard, preferably one which will register the minimum temperature. (See fig. 19.) Cheaper thermometers can be scattered throughout the remainder of the orchard. These should be carefully compared with the standard thermometer at least once each year and inaccuracies noted. Those which are found to be in error more than one degree near the freezing point should be discarded. Cards showing the corrections to be applied at different points on the scale to make the readings agree with the standard should be attached alongside all thermometers which are not strictly accurate.

MEASUREMENT OF ATMOSPHERIC MOISTURE.

On an earlier page of this bulletin reference has been made to the important influence of the water vapor in the atmosphere on the amount of fall in temperature during the night. A knowledge of the amount of moisture in the atmosphere is therefore of considerable value to the orchardist.

The temperature of the dew point is a direct index to the amount of water vapor in the atmosphere and also indicates the point at which dew or frost will begin to form as the temperature falls.

The simplest instrument for accurately determining the temperature of the dew point is the sling psychrometer. (See fig. 20.) This consists of two ordinary thermometers mounted side by side on an aluminum strip and provided with a handle for whirling. The bulb of the lower thermometer is covered with thin muslin. When an observation is to be made, the muslin is thoroughly moistened in clean water and the instrument is whirled rapidly for a short time. Immediately after the whirling is discontinued both thermometers are read as quickly as possible, the wet-bulb thermometer first. These readings are kept in mind or noted on paper and the psychrometer is immediately whirled again and more readings are taken. This is repeated several times, until two readings of the wet-bulb thermometer agree closely or until the wet-bulb temperature begins to rise. In other words, it is desired to

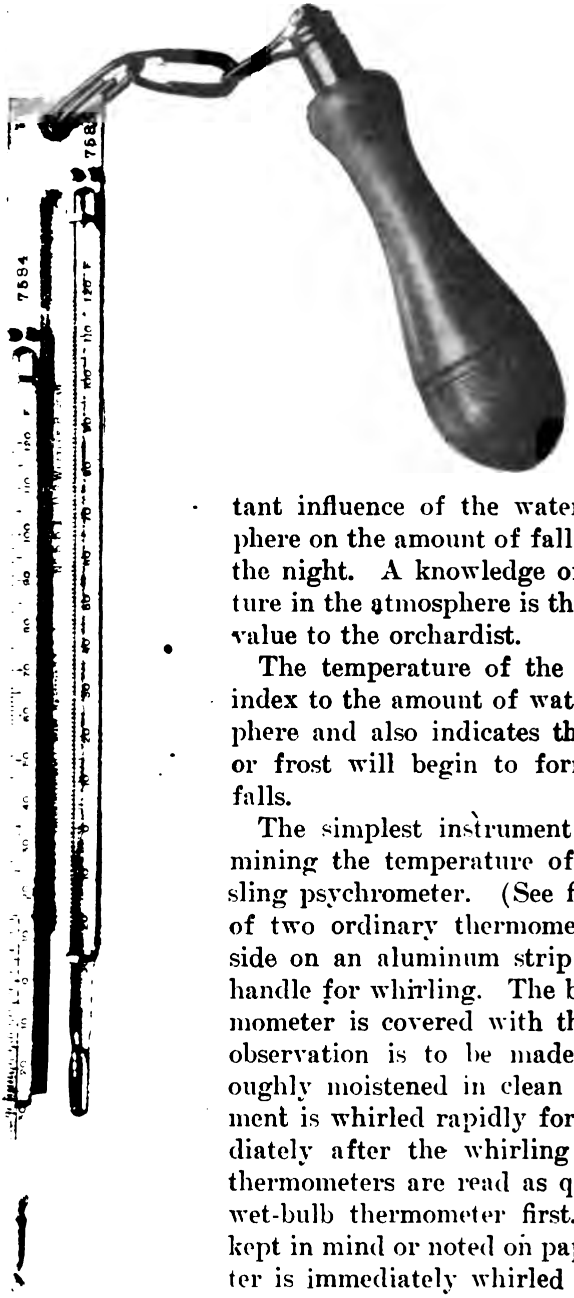


FIG. 20.—Sling psychrometer used to determine the amount of moisture in the atmosphere.

obtain readings of the two thermometers after the wet-bulb thermometer has reached its maximum depression.

If the wet-bulb temperature falls to 32° F. and remains at that point, the whirling should be continued for some time later, even though two or three successive whirlings fail to cause it to read lower. When the water in the muslin begins to freeze, sufficient latent heat is liberated to keep the temperature at 32° until all the water on the thermometer bulb is frozen. After this occurs, the evaporation from the ice may cause the wet-bulb thermometer to read below 32°.

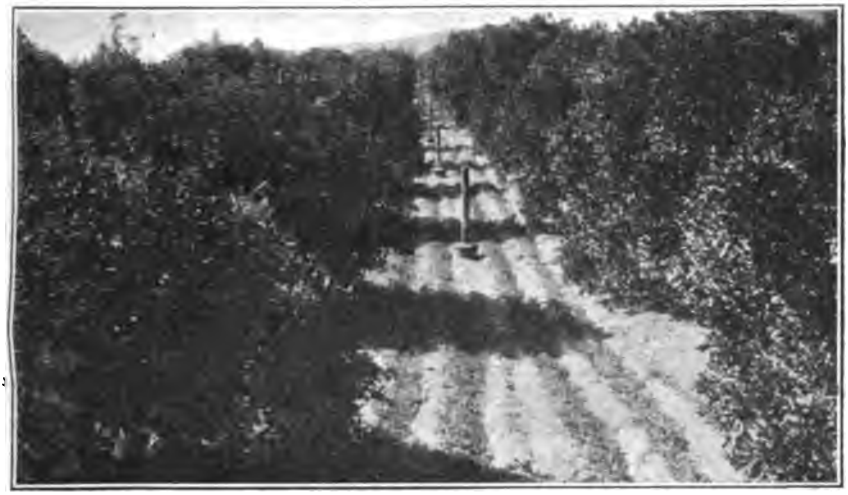


FIG. 21.—Improved high-stack heaters in place in orange grove.

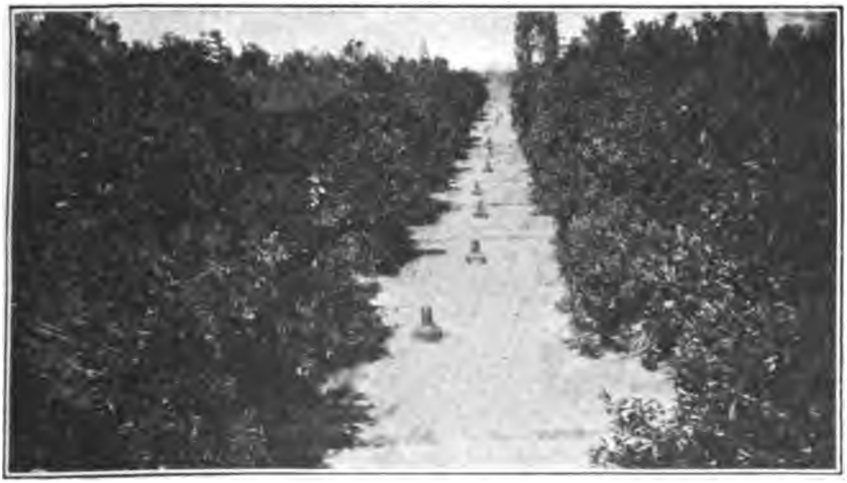


FIG. 22.—Short-stack oil heaters in place in an orange grove.

After the final readings have been made the wet-bulb temperature is subtracted from the dry-bulb temperature and the temperature of

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the dew point is found by referring to special tables, usually furnished with the psychrometer.

The psychrometer should be whirled and read in the shade.

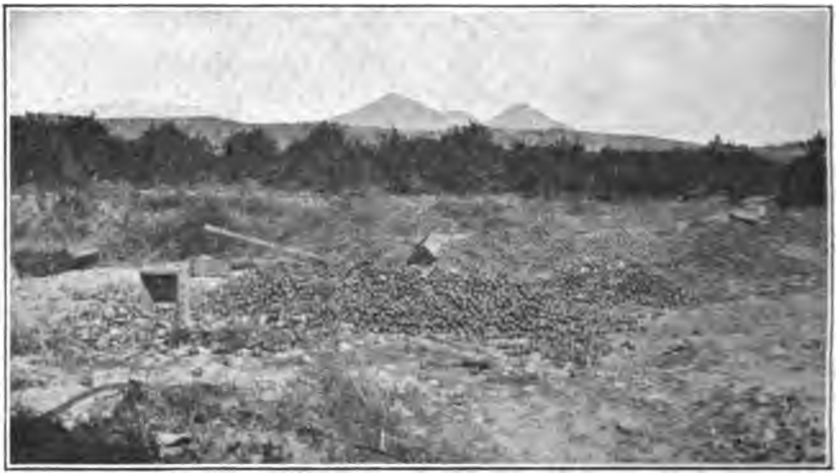

FIG. 23.—A corner of a frozen orange dump after a cold season. Thousands of dollars worth of otherwise perfect fruit a total loss through frost damage.

Considerable heat is required to evaporate water, and the heat removed from the bulb of the wet thermometer for this purpose causes its temperature to fall. The less moisture already in the atmosphere the more rapidly the evaporation goes on and the lower is the temperature of the wet bulb. When the atmosphere is saturated the readings of the dry and wet bulb thermometers are the same.

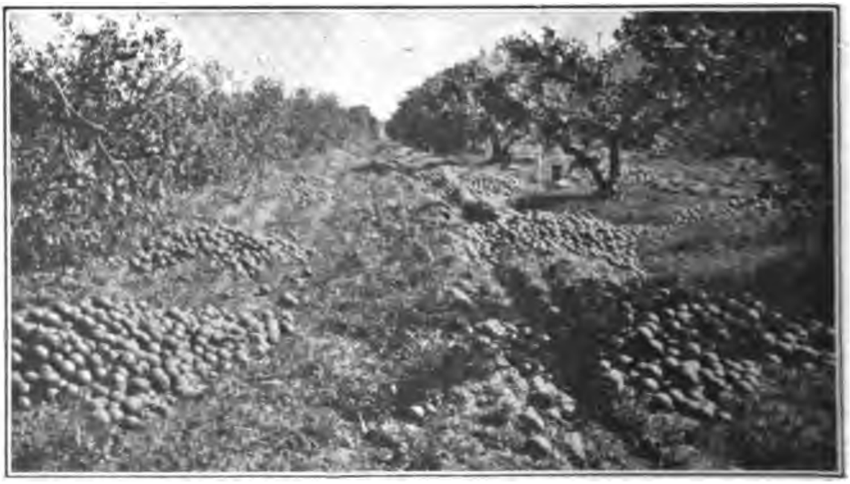

FIG. 24.—Frozen oranges dumped in lemon grove to be plowed under for fertilizer. Very little frozen fruit is used in this way, as most growers believe too much acid is added to the soil.

FARMERS' BULLETIN 1097
UNITED STATES DEPARTMENT OF AGRICULTURE

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The Stable Fly

How to Prevent Its Annoyance and Its Losses to Live Stock

THE ACUTE PAIN produced by the insertion of the proboscis of the stable fly brings to any man a sudden realization that this biting insect is pointedly different from the house fly or typhoid fly, although hitherto his opinion had been that the two were identical.

At times this fly becomes excessively abundant and occasions heavy losses among nearly all classes of live stock. Year in and year out it is a source of great annoyance, especially to horses and cattle, and is an all-too-common and persistent pest.

The adult stable fly resembles the house fly, but is slightly broader and feeds principally on the blood of animals, which it draws with its long, piercing mouth parts. It breeds in accumulations of various kinds of vegetable matter and also in manure, especially when the latter is mixed with straw. When straw stacks become wet soon after thrashing the flies breed in the decaying straw, and it is this set of conditions which produces the severe outbreaks.

Spraying animals with repellents is not very satisfactory, but the numbers of stable flies can be kept down by caring properly for stable refuse and by stacking or otherwise disposing of straw as described in subsequent pages of this bulletin.

This bulletin is a revision of Farmers' Bulletin 540, The Stable Fly
issued July 14, 1913

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief
Washington, D. C. April, 1920

THE STABLE FLY: HOW TO PREVENT ITS ANNOYANCE AND ITS LOSSES TO LIVE STOCK.

By F. C. Bishopp,

Entomologist, Investigations of Insects Affecting Health of Animals.

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A TORMENTING AND INJURIOUS PEST.

THE stable fly,[1] or stock fly, is one of the most important sources of annoyance to live stock throughout the United States. When present in small numbers it has no apparent injurious effect, but on frequent occasions conditions arise which permit its development in enormous numbers, and at such times the injury to all classes of live stock becomes marked.

In addition to being a source of annoyance to domestic animals, the stable fly, when present in large numbers, has a deleterious effect upon them owing to the quantity of blood drawn, and animals not infrequently are so reduced in vitality as to permit certain diseases to become acute and cause their death. In Africa and other parts of the world this fly is capable of transmitting certain serious maladies of horses and camels. In our country it probably plays a part in the dissemination of anthrax, and recent investigations indicate that the disease of horses known as swamp fever or infectious anemia is carried by it. Work thus far conducted indicates that the fly acts solely as a mechanical carrier, passing these diseases directly from one animal to another in biting.

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[1] Known scientifically as *Stomoxys calcitrans* L.

In addition to its rôle as a live-stock pest, the stable fly is important as an annoyer of man and there is some indication that it is concerned, in part at least, with the transmission of certain diseases of man, most notable of which is infantile paralysis.

THE COMMON NAMES OF THE INSECT AND HOW IT MAY BE RECOGNIZED.

"Stable fly" is not entirely satisfactory as a common name for this pest, as it is frequently abundant in open fields and along roadways and is not uncommonly encountered about the house. Nevertheless it is found about stables more frequently than anywhere else. In certain localities such names as the "stable fly," "wild fly," "straw fly," and "biting house fly" are applied to it.

As the last name suggests, this insect is frequently confused with the house fly[1]. The common house fly is not capable of biting, its mouth parts being soft and broad on the tip. On the other hand, the stable fly has mouth parts well fitted for piercing the skin of animals and sucking blood. The presence of such biting mouth parts, therefore, distinguishes it at once from the house fly. The tip of the beak can be seen protruding from beneath the front of the head when the fly is at rest (see figs. 4 and 5). The insect is usually slightly larger than the house fly and more robust. It usually alights upon an animal with the head directly upward, while another insect sometimes confused with it, the horn fly,[2] rests with its head downward, and the house fly may assume various positions and moves much more frequently. The horn fly is much smaller than the stable fly, the wings are widely spread at the tips, and it is usually present on cattle only, where it occurs in small swarms, moving from one part of the animal to another when disturbed.

DISTRIBUTION AND ABUNDANCE.

The stable fly is very widely distributed throughout the world. In fact it seems to have followed man and his domestic animals to all quarters of the globe. It becomes more abundant, however, in the temperate regions, such as the United States and Argentina. In the United States it is to be found everywhere, but within the confines of this country its abundance varies considerably.

Serious annoyance to live stock is most common in the Central States from Texas to Canada, where grain is grown extensively. Reports indicate that it may be important occasionally in various other sections and is a more or less persistent pest in all irrigated regions.

From time to time exceedingly severe outbreaks of this insect occur. One of the worst in recent years took place in 1912. Injury in northern Texas and in Oklahoma during the late summer and early fall of that year was unprecedented. The pest was abnormally numerous throughout the entire grain belt, including the southern portions of central Canada. Since 1912 the insect has appeared in great numbers on two or three occasions, but these outbreaks have been more or less local.

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[1] Known scientifically as *Musca domestica* L.

[2] Known scientifically as *Haematobia irritans* L.

This fly appears not infrequently on warm days during winter and early spring in the Southern States, but seldom does it become sufficiently abundant in any part of this country to cause annoyance before early summer. It nearly always increases in abundance and injury is most acute during August and September.

CHARACTER OF INJURY AND LOSSES.

Practically all warm-blooded animals are attacked by the stable fly, but some domestic species are much freer from injury than others. This is due largely to protection afforded by the hair of the host or by some of its habits. Mules, horses, cattle, hogs, dogs, cats, sheep, and goats are subject to attack in about the order named. The worriment caused to individual animals varies greatly with their temperament.

As has been indicated, this fly is of importance in a number of ways. There is little doubt that it is a potent factor in disease transmission, although actual proof of this has been secured in the case of a few diseases only.

Aside from conveying disease, this insect is of much importance on account of the worry produced by its bites. During severe outbreaks this is probably the most important cause of losses. In periods of great abundance all live stock are compelled to keep up a constant fight against flies from early morning until dark. At such times the flies are present not only around barns but in towns, cities, and open fields. Animals which are being worked in fields or on the streets and those kept in stables suffer alike. During the severe outbreak of 1912 many horses and cattle became so weak that they gave up the fight against the pest and the flies swarmed over them in countless numbers. In a few cases, where the animals were not promptly protected from attack, they succumbed in a short time.

The loss of blood during severe outbreaks is an important consideration. When fully engorged the abdomen of the fly is greatly distended, and it has been found that the blood extracted at one feeding is soon digested and the fly is ready for another meal. Thus animals continually exposed must serve to engorge thousands of individuals each day, each of the flies ingesting several drops of blood during a meal.

In the portion of the United States where Texas fever occurs, in addition to the live stock actually killed by worriment and loss of blood, a considerable number of cattle are lost from Texas fever. In most of these animals, although the disease organisms are latent in the blood, no apparent injury would result under conditions favorable to live stock. Under the strain of continually fighting the flies and with the weakened condition brought about by the loss of blood, however, an acute form of Texas fever is induced. When animals begin to suffer from the fever they are less energetic in fighting the flies and consequently become the more ready victims. During the outbreak in 1912 acute Texas fever was certainly produced as a result of fly attack. Owing to the continual biting of the insect the fever could not be reduced in many cases and the animals speedily died.

During severe outbreaks the milk supply in fly-infested zones is much reduced. In the 1912 outbreak many dairymen found that their output of milk was reduced from 40 to 60 per cent, and that in some cases cows were completely dried. For several months after the pest had abated, the effects of the outbreak were apparent in the reduced milk production. Even in cows which freshened several months after the pest had abated, the effect on milk yield was said to be apparent.

During 1912 all animals in the fly zone were greatly reduced in flesh. In many cases cattle which had been fat enough for market were so much reduced that they could not be sold. Horses and mules in many cases lost from 10 to 15 per cent in weight during the outbreak. Some dairy herds which were usually shown at the State fairs suffered such marked injury that they were not fit for exhibit.

In many cases the joints of both horses and cattle became so swollen and stiff, from standing in water where they sought protection from flies, that they could scarcely walk. The incessant stamping of the animals also had the effect of injuring the feet and joints. A number of liverymen found it necessary to discontinue making drives into the country, and some of their animals were completely disabled for regular work.

Another source of loss to farmers was their inability to proceed with their usual farm plowing and other operations at the proper time. In many sections the flies were so bad on the horses that they could not stand both the work and flies. Some men resorted to night work as a means of escaping the attack, but this was too severe for the teams, as the flies allowed them no rest during the day. Numerous instances of horses becoming frantic from irritation were recorded; these often resulted in runaways and consequent destruction. Animals which were not being worked sometimes received injuries from running into barbed wire fences in endeavoring to escape the flies.

The total loss due to the outbreak in 1912 is difficult to estimate. It is believed that in northern Texas over 300 head of cattle, mules, and horses were killed directly or indirectly as the result of the fly attack. The actual death loss may be conservatively placed at $15,000. The loss due to the reduction in milk supply may be reasonably placed at $10,000, and other losses far surpass these two items. Moreover, these were the losses experienced only in the few counties in northern Texas where the fly was most abundant and do not include the more or less serious injury sustained in practically the entire grain belt.

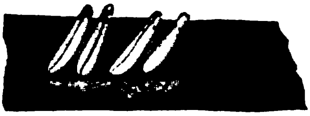

FIG. 1.—Eggs of the stable fly attached to a straw. Greatly enlarged.

SUMMARY OF LIFE HISTORY.

Like all other flies, this species has four stages in its life history, namely, the egg, larva, pupa, and adult.

The egg.—The eggs of this fly are elongate ovoid and of a creamy white color. They are about one twenty-fifth of an inch in length and under a magnifying glass show a distinct furrow along one side. When placed on any moist substance they hatch in from 1 to 3 days after being deposited. In hatching a small slit is made around one end of the groove, and the minute maggot crawls out. Figure 1 shows four eggs on a piece of straw; the two at the right have hatched.

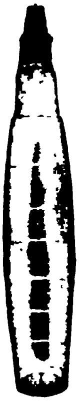

FIG. 2.—The stable fly: Larva, or maggot. Greatly enlarged.

The larva, or maggot.—When first hatched the larvæ, or maggots, are about one-twelfth of an inch in length and, being translucent, are not easily seen with the naked eye. Development takes place fairly rapidly when the proper food conditions are available, and the growth is completed within 11 to 30 or more days. When full grown the larvæ (fig. 2) are pale yellow or nearly white and about four-fifths of an inch in length. They have the typical shape and action of most maggots of this group of flies. The hind end is large and the body tapers to the head. The larva moves rapidly by means of minute projections on the edge of each segment along its under side. When exposed to the light it quickly disappears in the straw or other matter in which it is breeding.

The pupa.—When the larvæ are full grown they shorten and become thicker, and the skin contracts and hardens to form the case in which the transformation to the adult is to take place. This puparium, or pupal case (fig. 3), is rather soft and yellowish at first but soon becomes harder and changes to reddish brown. It is elongate oval, slightly thicker toward the head end, and from one-sixth to one-fourth of an inch in length. During this stage the insect is completely dormant, the transformation from maggot to adult fly going on within the puparium. This resting stage requires from 6 to 20 days, or in cool weather considerably longer.

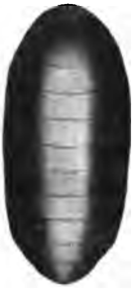

FIG. 3.—The stable fly: Pupa. Greatly enlarged.

The adult.—When the fly has completed its development within the puparium it pushes its head against the end until the shell splits open. Then it crawls out as an adult fly, but so different from the fly ordinarily seen that one would scarcely recognize it. the color is pale and the head bulges out in front between the eyes. At this time the wings are only small wrinkled sacs. In a few minutes air is forced into the wings, and they unfold slowly, the fly becomes gradually darker in color, and its body becomes harder. Up to this time the beak is not visible, as it is bent downward between the legs. Soon it becomes almost black and is brought forward in its natural position so that the tip may be seen from above. When completely dried out the adults show four rather distinct, dark, longitudinal markings on the thorax, as well as several dark spots on the abdomen. The male usually is slightly smaller than the female, the body of which measures from one-fourth to five-sixteenths of an inch in length. The adult, as seen from above, is shown in figure 4, and a side view of a female specimen engorged with blood is shown in figure 5.

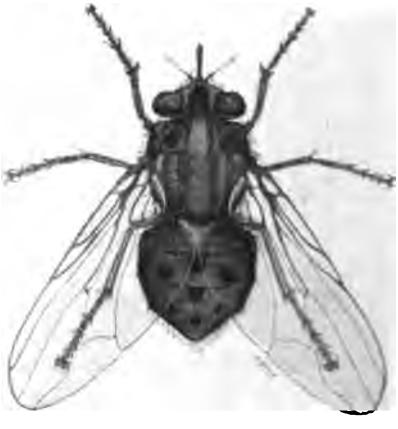

FIG. 4.—The stable fly: Adult as seen from above. Greatly enlarged.

DEVELOPMENT AND HABITS.

BREEDING PLACES.

Horse manure has been considered the normal breeding medium for this pest. Investigations made during the outbreak in 1912 showed clearly, however, that the vast majority of the flies bred out in straw stacks, and investigations made around stables and barns indicate that while the fly breeds in pure horse manure it favors a mixture of this substance with straw. The fly was found to be breeding in much greater abundance in oat straw than in wheat straw. This appeared to be due to the softer stems and the greater amount of leaves in the oat straw, which furnished better food and allowed the stacks to become more compact. Rice straw was found to furnish suitable breeding conditions, and there is little doubt that barley and rye often serve as food for the immature stages.

It has been found by Prof. Iches to breed in Argentina in great numbers in the débris left after thrashing flax. A careful examination of portions of alfalfa stacks which were moist and readily accessible to numbers of flies showed that they were not infested, nor were accumulations of weeds and bunches of grass in open fields. The insect occasionally may breed in broken-up masses of hay or dead grass, especially when these are permeated with liquids from manure, and corn husks in feeding pens have been found to harbor the maggots.

The manure piles commonly found near stables where horses are kept furnish suitable breeding conditions. This is especially true in the early spring, when the warmth of the manure appears to be very attractive to the flies for egg laying. Cow-lot manure which has become broken up, especially when mixed with waste feed, is utilized as a breeding place; and so is ensilage, particularly when mixed with straw, as is often the case when the bottom of a silo is cleaned out. Experimentally, a few specimens have been reared from pure cow manure, but this substance seems to be unattractive to the adult and not favorable for the breeding of the larvæ on account of its very compact texture.

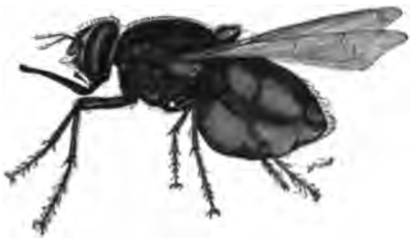

FIG. 5.—The stable fly: Adult female, side view, engorged with blood. Greatly enlarged.

The stable fly has never been found breeding in human excrement and does not frequent malodorous places, which are so attractive to the house fly; hence it is much less likely to carry typhoid and other germs which may be found in such places.

This insect develops somewhat more slowly than the house fly, and it is therefore more essential, in order that it may breed successfully, that the eggs be deposited in rather large accumulations of material. The larvæ are sensitive to drought and soon succumb if the material in which they are developing is not kept rather moist.

HABITS OF THE ADULT.

Both the male and female of this species feed on the blood of animals. They appear to discover their host mainly by sight and usually, especially on cattle, pass quickly to the lower portion of the legs, particularly on the outside, where the hair is somewhat shorter than on other parts of the animal and where they are less likely to be struck by the tail of the host. When the flies are very abundant their attack is by no means confined to the legs, as both cattle and horses have been seen practically covered with flies on all parts of the body. They seldom remain on the host long without inserting the beak. Before blood is extracted they are easily disturbed and often move about several times before settling down for final engorgement. After the beak is well inserted and the blood begins to flow they usually become engorged in from two to five minutes. The insertion of the beak is accompanied by a rather severe, sharp pain. This accounts for much of the worriment caused to the host. After blood extraction has begun little or no pain is felt. During feeding the abdomen becomes greatly distended (see fig. 5) and often of a distinctly reddish color. When satisfied the fly withdraws its beak and flies rather sluggishly to some near-by object, where it rests while digesting its meal. When the proboscis is withdrawn a drop of blood usually exudes from the wound. Numerous small flies have been seen to frequent the blood which exudes in this way, and it is not improbable that the screw-worm fly[1] may deposit its eggs on these spots and thus cause infestation of the host with these maggots.

During warm weather the blood is digested rapidly and the flies may feed again the same day. When the weather is cooler they usually require about a day for the digestion of the blood. After partaking of a meal the flies, during hot weather, ordinarily alight on the walls of buildings or on foliage of plants in shady situations. When the temperature is lower they remain in the sunlight, but in all cases they tend to avoid strong wind.

Adults frequently follow for considerable distances teams traversing roads and finally, when engorged, settle on near-by objects. Other teams which pass along the same highways are thus frequently attacked by flies which have completed the digestion of their previous meal, and this has given rise to the idea that the flies are breeding in weeds, grass, and hedges along the highways. This is also a means by which the flies invade territory beyond that in which they develop. Adults have been observed to travel many miles in the passenger coaches of railways. Few individuals are carried in this way, but doubtless the spread of the species is aided and, what is more important, diseases might be spread in this way by infected flies.

Feeding may take place a number of times. Experimentally individual flies have been induced to engorge as many as 14 times. Flies have been observed to partake of water and to feed to some extent on succulent fruit. They feed commonly on the moisture on fresh manure and on rotting straw. Although man is bitten by these flies occasionally, horses and cattle seem to be preferred as hosts.

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[1] Known scientifically as *Chrysomyia macellaria* Fab.

REPRODUCTION.

Mating of the flies takes place while they are not on hosts, and egg laying soon follows, provided the flies have fed a sufficient number of times. It seems that at least three feedings on blood are necessary for the production of eggs. After the third meal is digested the flies seek suitable places for oviposition. When the weather is cool additional feedings are often necessary before eggs are produced. The adults appear to have a keen sense of smell and are able to detect moist straw and suitable manure very quickly. This is especially noticeable when a straw stack which is dry on the outside is opened up so as to expose the moist and rotting interior.

Very soon after a stack is opened flies are seen to come to the moist straw in numbers and begin depositing eggs. Usually they crawl into the loose straw, sometimes going to a depth of several inches. When laying eggs the fly greatly extends the ovipositor and uses it as an organ of touch in locating a suitable spot. The eggs are laid in irregular masses, although occasionally single ones are deposited. The female usually moves several times during oviposition so that each mass contains from a few to as many as 25 or more eggs. The greatest number of eggs which has been observed to be deposited before another meal of blood is taken is 122. After all of the eggs have been deposited the female again seeks a host, and this feeding is again followed by egg laying. Three or more of such ovipositions commonly take place in this species. It is sometimes necessary, especially during cool weather, for a fly to become engorged twice before each oviposition following the first. The greatest number of eggs which has been seen to be deposited by a single female during her life is 632.

LENGTH OF LIFE OF THE ADULT.

A knowledge of the length of life of the adult is important in determining its possibilities as a disease carrier and annoyer of animals. Individuals kept in small tubes without food or water during hot weather died within 2 days. When water and sugar sirup were supplied to flies, in a screen cage about 1 foot square, one specimen out of a large number of males and females lived for 23 days. Individuals which had access to blood at frequent intervals lived 17 days, and a few specimens, among a considerable number which were kept in large cages with cattle and suitable material in which to deposit eggs, lived for 29 days. Under more abnormal conditions other investigators have kept individuals alive more than three months.

THE LARVA AND ITS HABITS.

The larvæ, or maggots, begin feeding as soon as they hatch from the eggs and continue to do so throughout their growth. Portions of moist straw or other material in which they are breeding are torn off by their mandibles, which are located on the narrow or head end of the maggot. When very small they frequently penetrate between the layers of the stalk or leaves of grain when moistened in the straw stack. When larger they often feed within the straws, and transformation to the resting state sometimes takes place in this protected situation.

The larval period lasts from 11 to 30 days, and during very cold weather probably considerably more than a month. The character and abundance of food and the amount of moisture have an important influence on development, and larvæ follow the moisture inward as the material in which they are breeding becomes dry on the surface. Pupation occurs anywhere in the breeding material; it frequently happens, however, that the larvæ, when in small masses of straw or manure, work downward as the material dries and pupate at the surface of the soil.

LIFE CYCLE.

Complete development from the deposition of the egg to the emergence of the adult fly may take place in 19 days, or even in 14 days, according to some investigators. The developmental period, however, usually ranges from 21 to 25 days, where conditions are favorable. Forty-three days is the longest period observed, although it is certain that in the late fall and during the winter months a much longer period is often necessary. The finding of full-grown larvæ and pupæ in straw during the latter part of March, 1913, in northern Texas, shows that development may require about 3 months, as these stages almost certainly developed from eggs deposited the previous December.

HIBERNATION.

In the southern part of the United States there is no true hibernation of this insect. Adults have been found to emerge from their breeding material at various times during the winter when temperatures were not low. It is doubtful if adults appearing under these conditions ever lay eggs. The individuals which pass the winter successfully hatch from eggs laid in the fall and continue development slowly during the winter, emerging in early spring when the temperatures are favorable for reproduction. In the northern part of the United States few flies emerge during the winter months, this period being passed normally in the larval and pupal stages.

AGRICULTURAL PRACTICES IN RELATION TO FLY ABUNDANCE.

Certain agricultural practices favor greatly the development of the stable fly. As has been stated, this species breeds most commonly in straw and horse manure or in a mixture of these two substances. The custom of allowing the manure from the horse stable to accumulate just outside of the stable doors insures the presence of stable flies at all times when climatic conditions are suitable for breeding. Allowing barnyards, especially around dairies, to become knee-deep in manure is also calculated to produce flies in abundance.

In the grain belt it is the practice of farmers to thrash the grain in the fields by means of self-stacking thrashing machines. The individual stacks cover much ground and the straw is very loosely piled. In many cases for convenience several stacks are formed in various parts of a field. When thrashing is followed by heavy summer and fall rains this loosely piled straw is certain to form a breeding place for great numbers of flies. This is precisely what occurred in 1905, 1912, and subsequent years when there were serious outbreaks of the stable fly in Texas. In many instances straw stacks are not protected from live stock. The animals soon scatter the straw and by adding manure still further favor fly breeding. These straw stacks usually are allowed to remain throughout the fall and winter without attention. When the succeeding crop is planted the area occupied by the stacks is simply left uncultivated. Occasionally straw stacks occupy as much as an acre of ground. In a few cases stacks are burned in the spring, but frequently they are left from year to year and the new straw added to the old stacks, destruction only taking place when the stacks become exceedingly large.

It will be seen that these practices not only encourage the breeding of the stable fly, but when the straw becomes sufficiently rotten and compact the house fly as well breeds in it in abundance. Throughout the grain belt a very considerable amount of valuable land is thus left untilled and the full manurial value of the straw is lost. That the stacks serve some purpose as shelter and feed for live stock kept in the fields during winter is the only legitimate reason for not scattering them or burning them in the late summer or fall.

NATURAL CONTROL.

CLIMATIC EFFECT.

The flies feed when the temperature is very high and the sun bright and hot as well as during cool and cloudy weather. They have been observed to attack animals during drizzling rain, and when somewhat protected by sheds and stables they often feed during heavy rain. The lowest temperature at which flies have been observed to partake of blood was 55° F. When the temperature goes below 60° F. their desire to feed is less marked. Between 40° and 48° F. they lose their ability to fly, and complete inactivity occurs when the temperature ranges between 31° and 45° F. This range of activity is due to variation in individual flies, to the rapidity of the decline or rise in temperature, and to the minimum temperature experienced by the individuals. No flies appear to be killed by a temperature not lower than 27° F., and some at least are able to survive temperatures considerably below this point. All flies at Dallas, Tex., seem to have been killed when the temperature reached 8° F. As has been stated, the flies always seek shady places during hot weather, but when the temperatures are lower they delight to dart about in the sun in a manner very similar to that of the house fly.

The maggots, or larvæ, are very susceptible to drying. This is particularly true soon after they have hatched. Excessive hatched. Excessive moisture, also, is detrimental to their development, and flooding kills them in a few hours. They appear to be able to endure rather high temperatures when abundant moisture is at hand, although the heat produced in manure and straw stacks is often sufficient either to kill them or to drive them outward. No doubt the generation of heat within the breeding places stimulates the development of the immature stages during the fall and winter months. Light is detrmental to the development of the larvæ. When placed in bright daylight, even though sheltered from the sun, larvæ have never been known to complete development. These facts make it possible to destroy the pest in this stage of its life.

The pupæ of the insect, being inactive and protected, are much less susceptible to all climatic extremes. They appear to be able to withstand low temperatures and are not very susceptible to heat or drying, especially after development of the fly has proceeded for some time.

PREDATORY ENEMIES.

Hogs, as well as chickens and other poultry, are capable of destroying great numbers of the immature stages of the stable fly. They are attracted to the straw stacks and manure piles partly by the grain, and incidentally they destroy the maggots and pupæ which they find. Several kinds of insects are important destroyers of these stages. Certain beetles devour them in considerable numbers. The adult flies fall prey to numerous enemies. Among the more important enemies of the adults are the large robber flies, which may be seen in great numbers around straw stacks, pouncing upon stable flies which are depositing eggs or resting upon straw. Wasps of several kinds capture the flies that are attacking stock or flying about. When filled with blood the flies are comparatively sluggish and much more easily caught by these enemies, and spiders often devour them.

PARASITES.

Two species of small wasplike insects have been found to breed within the pupæ of the stable fly. These insects deposit their eggs through the hard puparium, and instead of an adult stable fly the little parasite emerges. In some cases, where the immature stages of the fly were concentrated in great numbers, as many as 40 per cent of the pupæ were found to have been destroyed by these parasites. At least one of the parasites[1] has a wide distribution in this country.

ARTIFICIAL CONTROL.

As is the case with most insects, the destruction of the stage which is actually doing the injury is most desired by those concerned. With this species, as with many others, this is very difficult, and some more easy way of securing the desired end must be determined. With the stable fly the natural point of attack is found in the immature stages, and there is every reason to believe that by properly caring for substances in which it breeds the insect may be kept well under control.

PROTECTION OF LIVE STOCK FROM ATTACK OF THE STABLE FLY.

When adult flies are present in great numbers it is necessary to devise some means of protection against them, especially since we know that every individual is capable of feeding a number of times before it dies. During the recent outbreak in Texas many different substances were tried. Most of the materials used with a view to repelling the flies from live stock have been found to be ineffective, and although some gave a measure of protection for a time, none had a lasting effect. In addition to the temporary value of these substances, in many cases injury was produced by their application, especially if persisted in often enough to keep the flies away. These facts emphasize the importance of taking steps to prevent fly breeding rather than depending on protection of the stock against the flies.

Many malodorous mixtures, particularly of an oily nature, have some value as repellents, but in preparing these care should be taken that they are not made too strong, particularly when animals are being worked in the hot sun, as they are likely to cause overheating and often produce shedding of the hair. A mixture of fish oil (1 gallon), oil of pine tar (2 ounces), oil of pennyroyal (2 ounces), and kerosene (½ pint) was found to be fairly effective in keeping the flies off of live stock for a short time when applied lightly, but thoroughly, to the portions of animals not covered with blankets or nets.

Work animals may be largely protected from the pest by means of coverings. One type of covering which has been found very effective and inexpensive consists of a blanket made of double thickness of burlap so arranged as completely to cover the back, sides, and neck of the animal (fig. 6). The legs also are then sometimes covered by means of old trousers slipped on over the feet and tied over the back. Leather nets or strips of leather attached to the bridle also aid in keeping the flies from the head. The ordinary fly net has been found to be of little value as it only tends to displace the flies temporarily and cause them to settle in places not covered by the net.

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[1] *Spalangia muscidarium* Richardson.

Completely darkened stables offer much protection from the flies, although the resulting lack of ventilation is objectionable. The thorough screening of all windows and doors is much more desirable. When screened barns are used care should be taken to brush the flies from the animals, when they are about to enter, by means of nets over the doorway, or with sacks. Little can be done to protect range stock from the flies. On hog farms a freshly plowed trench affords considerable protection to the swine. The sides of these trenches may be smeared with petroleum which is rubbed off on the hogs and acts as a repellent. The trench may be used also for sheep and cattle, but the petroleum in their case is unnecessary.

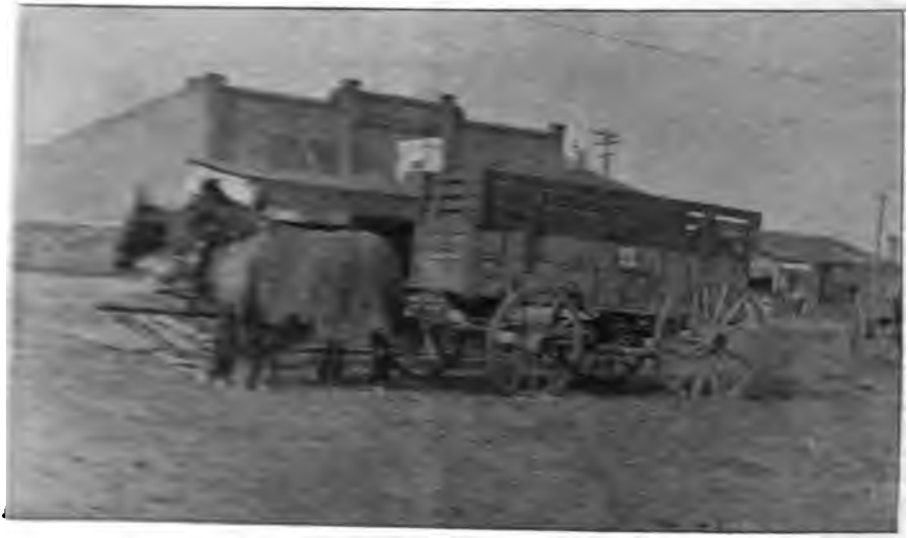

FIG. 6.—Burlap covering used to protect horses from the stable fly.

TRAPPING THE FLIES.

It has not been possible successfully to capture adult flies by means of the ordinary traps used for the house fly. A trap has been designed especially for this species, however, which may be utilized in capturing the flies in and about dairy barns. This trap is undoubtedly very efficient under certain conditions and has the advantage of catching not only the stable fly but the house fly and other obnoxious species.

In order to employ the trap for the stable fly it should be built in a frame so as to fit closely in a window, preferably on the brightest side of the barn and close to the cows or horses kept within. Other windows should be darkened by hanging gunny sacks over them. This may be done so as not to interfere with ventilation, and by flapping in the wind and darkening, both drive and cause flies to be attracted to the light-trap window.

Prof. Hodge has very kindly permitted the use of some of his illustrations of this trap (figs. 7, 8, 9), and his description of its construction has been followed. At the bottom of the trap a space about one-fourth of an inch wide running entirely across the window is left on both sides of the frame. This crack admits the flies beneath a roof or ridge of screen wire having holes large enough for flies to go through punched along its top at 2-inch intervals. To capture the house fly, bait consisting of any material attractive to them is placed in pans beneath this ridge. The flies enter this space, ascend through the holes, and are unable to escape. The sides of the trap, also, are made of ordinary screen wire bent inward and upward in two horizontal folds running across the window, one toward the bottom and one toward the top. The ends of the screen are then securely tacked and a series of small holes punched along the inner edge of each of the folds. The flies, in trying to go in and out through the window, crawl into the folds and enter the holes at the apex, but never escape, as on the inside the holes are along the projecting ridge. Prof. Hodge states that a trap set in a window in a basement barn near a cow within caught nearly 5 quarts of flies from July 1 to November 1. The stable fly constituted 90 per cent of these flies.

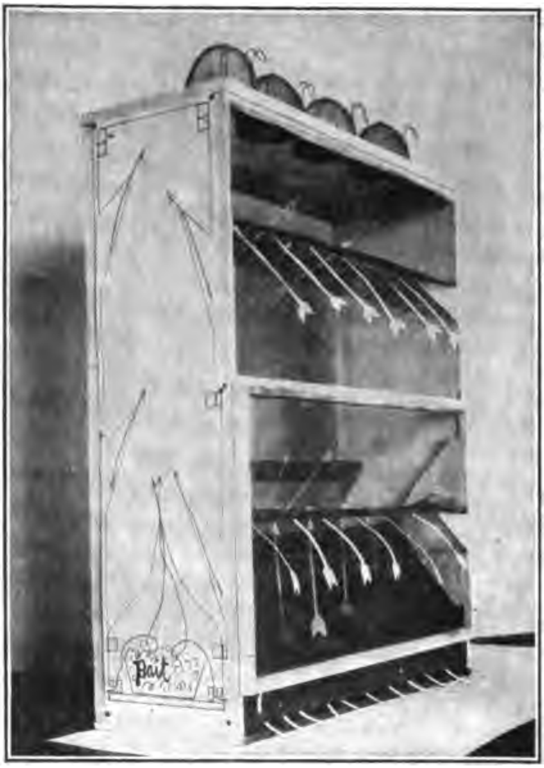

FIG. 7.—The Hodge flytrap, showing where the flies enter. (Hodge.)

This trap is inexpensive and can be made by anyone with a box, or box lumber, and screen wire. It is especially well adapted to well-made barns where the flies do not have numerous places for entrance and exit. It is also more applicable to small barns in which animals are kept more or less constantly than to large dairy barns where the cows are brought in only at milking time. Under the latter conditions the flies enter the barns on the cows and many remain on the walls of the barn until after the cattle have been turned out. In some cases where flies are concentrated in dairy barns in this manner they have been driven out by forcing live steam into the building from the boilers used for sterilizing purposes. Where such arrangements are made the flies may be caught in such traps as the one described, as they are endeavoring to escape from the barn, which should first be tightly closed.

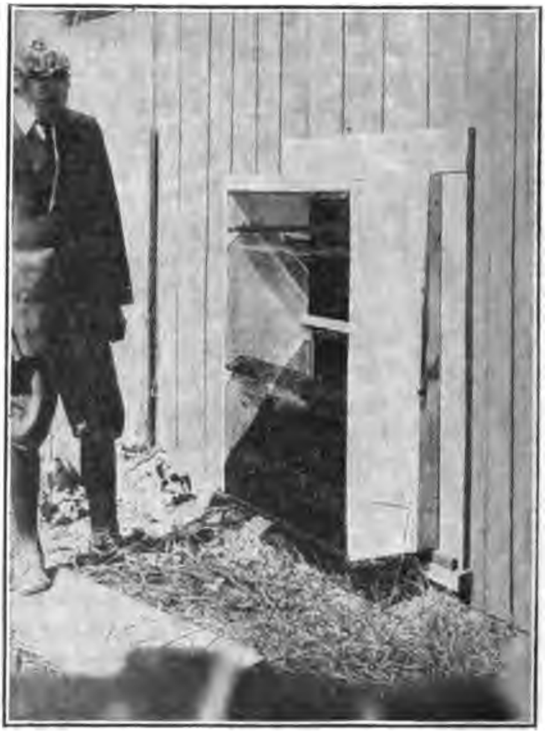

FIG. 8.—The Hodge flytrap fitted to a barn window. (Hodge.)

If such barns are tightly closed, as above, during the light part of each day and the windows without traps darkened, practically all the flies will "catch themselves" in trying to escape through the trap-window or windows.

DESTRUCTION OF IMMATURE STAGES AND PREVENTION OF BREEDING.

Since straw stacks have been found to be the principal breeding places of this insect in the grain belt, the proper care of the straw is by far the most important step in control. When the straw is to be kept for protection and food for live stock, it should be stacked with more than ordinary care. The sides of the stack should be made nearly vertical and it should be rounded up well on top, the better to shed the rain. With blower stackers a very satisfactory stack can be put up by controlling the blower and keeping one or two men on the stack. This method is shown in figure 10. After the stack is complete it is advisable to clean up around its base and to scatter or burn the loose straw and chaff.

So far as possible, all straw which is not required for winter feed for stock should be disposed of immediately by scattering it over the land soon after thrashing and subsequently plowing it under, or by burning the stacks. The plowing under of the straw which can not be used for feed is the most advisable procedure, in regions where the moisture is sufficient to cause it to rot rapidly. Oat straw is most generally used for feeding purposes, and this straw forms the principal breeding ground for flies. It is therefore important in regions where rainfall is heavy that all oat straw needed for feed or bedding be baled and stored under cover and that the remainder be promptly burned or scattered. In the dryer sections of the country proper stacking of the straw may be depended upon for its preservation.

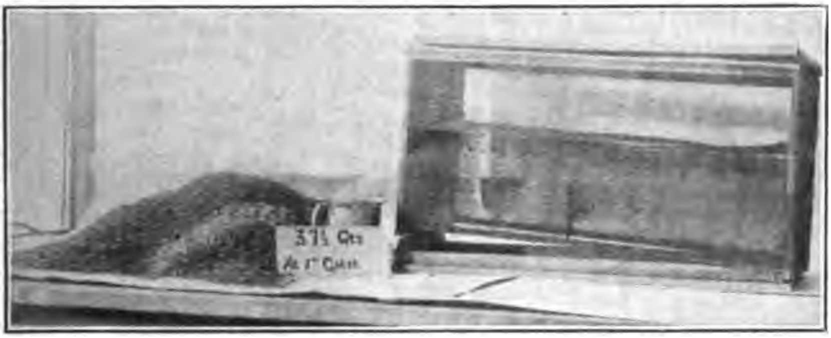

Fig. 9.—Pile of flies caught in a Hodge flytrap. (Hodge.)

All straw stacks not consumed by stock during the winter should be promptly disposed of in the early spring, as these stacks furnish flies continuously during spring and summer. Often the flies reared in such situations are abundant enough to cause great annoyance to live stock during early spring, and by multiplying throughout the summer an almost incredible number are produced by fall.

The conditions—that is, the heavy rainfall on the freshly thrashed straw—which have produced most of the severe outbreaks render the straw largely unfit for feed for live stock, as the stacks in many cases are wet through and soon become heated and rotten. In such instances, where the flies are already breeding in these stacks, their immediate destruction by burning or scattering is necessary to relieve the conditions. When stacks are scattered the work should be done thoroughly, so as to expose the straw completely to the influence of the sun, wind, and light. By this procedure practically all of the larvæ and many of the pupæ are destroyed. Straw spreaders are on the market which are said to give satisfaction.

It is best to plow under the scattered straw soon after it has become well dried out. In many sections of the grain belt plowing is not generally practiced, the land being simply disked prior to seeding. The scattering of straw over the ground in such cases is less practicable than where the land is plowed; hence wherever plowing can be done it should be adopted.

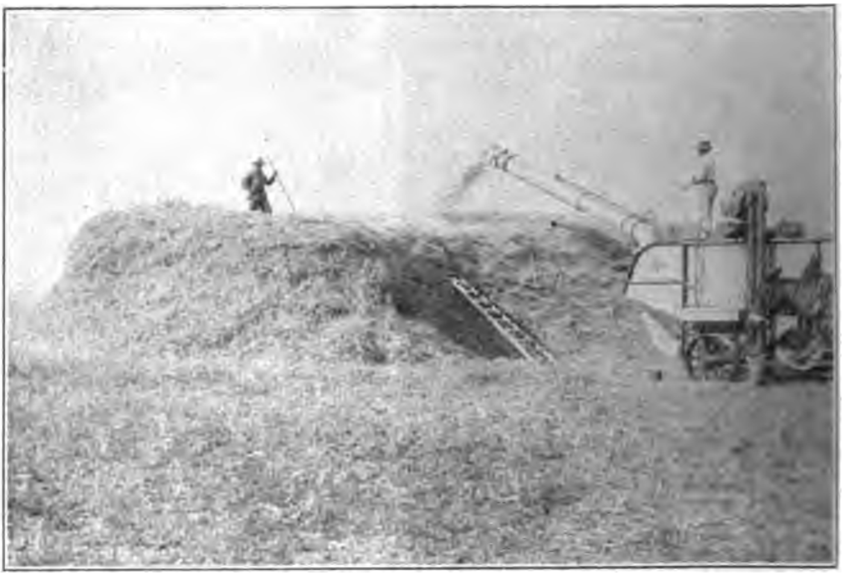

FIG. 10.—Stacking straw to prevent stable fly breeding.

In sections of the country where headers instead of binders are used, and consequently a smaller amount of straw is accumulated, the straw is much more easily disposed of by the methods just outlined.

The use of poisons or other substances, with a view of destroying immature flies in the substances in which they are breeding, is neither practicable nor advisable. Enormous quantities of these materials would be required to permeate the straw or manure piles to kill the flies, and, even though the flies were destroyed, the straw would be rendered dangerous to live stock.

Although straw is the principal breeding place for stable flies within the grain belt, there is no doubt that thousands of them develop in manure piles. Moreover, such material is utilized extensively as a breeding place for the house fly and horn fly. Hence the proper care of all sorts of animal refuse is essential for successfully combating the pest. Manure should be hauled out and scattered at regular intervals, preferably every three days, as is recommended for the control of the house fly, and any accumulations of straw or hay, especially adjacent to stables, should be disposed of, as these are often utilized for the breeding of the stable fly when larger accumulations of horse manure and straw are not available.

Manure boxes provided with a trap on top to catch the flies which breed out (fig. 11) prove very satisfactory for farms with a few head of stock. The box should be as nearly fly-proof as possible and the manure put into it at least every four days so as to catch the house flies as well as stable flies.

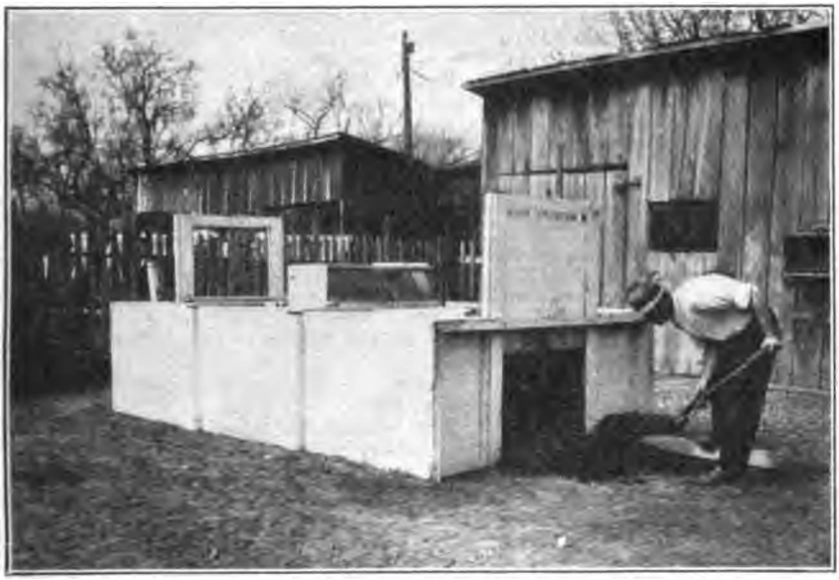

FIG. 11.—Manure box with flytrap attached.

Manure pits properly screened and with flytraps provided are adaptable to use on dairy farms, and the maggot trap described in Farmers' Bulletin 851 will destroy many stable fly maggots as well as those of the house fly.

The need of properly caring for stable refuse is still further emphasized by the fact that there are far more manure piles than straw stacks. Furthermore, the stable manure is usually in close proximity to the habitations of man and thus furnishes flies which have freer access to man, with consequent greater potentiality as disseminators of human diseases.

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1097

The STABLE FLY

How to Prevent Its Annoyance and Its Losses to Livestock

THE ACUTE PAIN produced by the insertion of the proboscis of the stable fly brings to any man a sudden realization that this biting insect is pointedly different from the house fly or typhoid fly, although hitherto his opinion had been that the two were identical.

At times this fly becomes excessively abundant and occasions heavy losses among nearly all classes of livestock. Year in and year out it is a source of great annoyance, especially to horses and cattle, and is an all-too-common and persistent pest.

The adult stable fly resembles the house fly, but is slightly broader and feeds principally on the blood of animals, which it draws with its long, piercing mouth parts. It breeds in accumulations of various kinds of vegetable matter and also in manure, especially when the latter is mixed with straw. When straw stacks become wet soon after threshing the flies breed in the fermenting straw, and it is this set of conditions which produces the severe outbreaks.

Spraying animals with repellents is not very satisfactory, but the numbers of stable flies can be kept down by caring properly for stable refuse and by stacking or otherwise disposing of straw as described in subsequent pages of this bulletin.

This bulletin is a revision of and supersedes Farmers' Bulletin 540, The Stable Fly.

Washington, D. C.   Issued April, 1920; revised November, 1927

THE STABLE FLY: HOW TO PREVENT ITS ANNOYANCE AND ITS LOSSES TO LIVESTOCK

By F. C. Bishopp, *Senior Entomologist, Division of Insects Affecting Man and Animals, Bureau of Entomology*

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A TORMENTING AND INJURIOUS PEST

The stable fly,[1] or stock fly, is one of the most important sources of annoyance to livestock throughout the United States. When present in small numbers it has no apparent injurious effect, but on frequent occasions conditions arise which permit its development in enormous numbers, and at such times the injury to all classes of livestock becomes marked.

In addition to being a source of annoyance to domestic animals, the stable fly, when present in large numbers, has a deleterious effect upon them owing to the quantity of blood drawn, and animals not infrequently are so reduced in vitality as to permit certain diseases to become acute and cause their death. In Africa and other parts of the world this fly is capable of transmitting certain serious maladies of horses and camels. In our country it probably plays a part in the dissemination of anthrax, and other investigations indicate that the disease of horses known as swamp fever or infectious anemia is carried by it. Work thus far conducted indicates that the fly acts solely as a mechanical carrier, passing these diseases directly from one animal to another in biting.

In addition to its rôle as a livestock pest, the stable fly is important as an annoyer of man, and there is some indication that it is concerned, in part at least, with the transmission of certain diseases of man, most notable of which is infantile paralysis.

THE COMMON NAMES OF THE INSECT AND HOW IT MAY BE RECOGNIZED

"Stable fly" is not entirely satisfactory as a common name for this pest, as it is frequently abundant in open fields and along roadways and is not uncommonly encountered about the house. Nevertheless it is found about stables more frequently than anywhere else. In certain localities such names as the "stable fly," "wild fly," "straw fly," and "biting house fly" are applied to it.

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[1] Known scientifically as *Stomoxys calcitrans* L.

As the last name suggests, this insect is frequently confused with the house fly.[2] The common house fly is not capable of biting, its mouth parts being soft and broad on the tip. On the other hand, the stable fly has mouth parts well fitted for piercing the skin of animals and sucking blood. The presence of such biting mouth parts, therefore, distinguishes it at once from the house fly. The tip of the beak can be seen protruding from beneath the front of the head when the fly is at rest. (See figs. 4 and 5.) The insect is usually slightly larger than the house fly and more robust. It usually alights upon an animal with the head directly upward, while another insect sometimes confused with it, the horn fly,[3] rests with its head downward, and the house fly may assume various positions and moves much more frequently. The horn fly is much smaller than the stable fly, the wings are widely spread at the tips, and it is usually present on cattle only, where it occurs in small swarms, moving from one part of the animal to another when disturbed.

DISTRIBUTION AND ABUNDANCE

The stable fly is very widely distributed throughout the world. In fact it seems to have followed man and his domestic animals to all quarters of the globe. It becomes more abundant, however, in the temperate regions, such as the United States and Argentina. In the United States it is found everywhere, but within the confines of this country its abundance varies considerably.

Serious annoyance to livestock is most common in the Central States from Texas to Canada, where grain is grown extensively. Reports indicate that it may be important occasionally in various other sections and is a more or less persistent pest in all irrigated regions.

From time to time exceedingly severe outbreaks of this insect occur. One of the worst in recent years took place in 1912. Injury in northern Texas and in Oklahoma during the late summer and early fall of that year was unprecedented. The pest was abnormally numerous throughout the entire grain belt, including the southern portions of central Canada. Since 1912 the insect has appeared in great numbers on three or four occasions, but these outbreaks have not been so widespread.

This fly appears not infrequently on warm days during winter and early spring in the Southern States, but seldom does it become sufficiently abundant in any part of this country to cause annoyance before early summer. It nearly always increases in abundance and injury is most acute during August and September.

CHARACTER OF INJURY AND LOSSES

Practically all warm-blooded animals are attacked by the stable fly, but some domestic species are much freer from injury than others. This is due largely to protection afforded by the hair of the host or by some of its habits. Mules, horses, cattle, hogs, dogs, cats, sheep, and goats are subject to attack in about the order named. The distress caused to individual animals varies greatly with their temperament.

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[2] Known scientifically as *Musca domestica* L.

[3] Known scientifically as *Haematobia irritans* L.

As has been indicated, this fly is of importance in a number of ways. There is little doubt that it is a potent factor in disease transmission, although actual proof of this has been secured in the case of a few diseases only.

Aside from conveying disease, this insect is of much importance on account of the worry produced by its bites. During severe outbreaks this is probably the most important cause of losses. In periods of great abundance all livestock are compelled to keep up a constant fight against flies from early morning until dark. At such times the flies are present not only around barns but in towns, cities, and open fields. Animals which are being worked in fields or on the streets and those kept in stables suffer alike. During the severe outbreak of 1912 many horses and cattle became so weak that they gave up the fight against the pest and the flies swarmed over them in countless numbers. In a few cases, where the animals were not promptly protected from attack, they succumbed in a short time.

The loss of blood during severe outbreaks is an important consideration. When fully engorged the abdomen of the fly is greatly distended, and it has been found that the blood extracted at one feeding is soon digested and the fly is ready for another meal. Thus animals continually exposed must serve to engorge thousands of individuals each day, each of the flies ingesting several drops of blood during a meal.

In the portion of the United States where Texas fever occurs, in addition to the livestock actually killed by harassment and loss of blood, a considerable number of cattle are lost from Texas fever. In most of these animals, although the disease organisms are latent in the blood, no apparent injury would result under conditions favorable to livestock. Under the strain of continually fighting the flies and with the weakened condition brought about by the loss of blood, however, an acute form of Texas fever is induced. When animals begin to suffer from the fever they are less energetic in fighting the flies and consequently become the more ready victims. During the outbreak in 1912 acute Texas fever was certainly produced as a result of fly attack. Owing to the continual biting of the insect the fever could not be reduced in many cases and the animals speedily died.

During severe outbreaks the milk supply in fly-infested zones is much reduced. In the 1912 outbreak many dairymen found that their output of milk was reduced from 40 to 60 per cent and that in some cases cows were completely dried. For several months after the pest had abated the effects of the outbreak were apparent in the reduced milk production. Even in cows which freshened several months after the pest had abated, the effect on milk yield was said to be apparent.

During 1912 all animals in the fly zone were greatly reduced in flesh. In many cases cattle which had been fat enough for market were so much reduced that they could not be sold. Horses and mules in many cases lost from 10 to 15 per cent in weight during the outbreak. Some dairy herds which were usually shown at the State fairs suffered such marked injury that they were not fit for exhibit.

In many cases the joints of both horses and cattle became so swollen and stiff, from standing in water where they sought protection from flies, that they could scarcely walk. The incessant stamping of the animals also had the effect of injuring the feet and joints. A number of liverymen found it necessary to discontinue making drives into the country, and some of their animals were completely disabled for regular work.

Another source of loss to farmers was their inability to proceed with their usual farm plowing and other operations at the proper time. In many sections the flies were so bad on the horses that they could not stand both the work and flies. Some men resorted to night work as a means of escaping the attack, but this was too severe for the teams, as the flies allowed them no rest during the day. Numerous instances of horses becoming frantic from irritation were recorded; these often resulted in runaways and consequent destruction. Animals which were not being worked sometimes received injuries from running into barbed wire fences in endeavoring to escape the flies.

The total loss due to the outbreak in 1912 is difficult to estimate. It is believed that in northern Texas over 300 head of cattle, mules, and horses were killed directly or indirectly as the result of the fly attack. The actual death loss may be conservatively placed at $15,000. The loss due to the reduction in milk supply may be reasonably placed at $10,000, and other losses far surpass these two items. Moreover, these were the losses experienced only in the few counties in northern Texas where the fly was most abundant and do not include the more or less serious injury sustained in practically the entire grain belt, and elsewhere in the country.

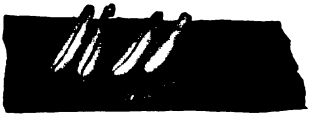

FIG. 1.—Eggs of the stable fly attached to a straw. Greatly enlarged

In the Corn Belt where many cattle are fattened the stable fly is a source of much loss. Feeders frequently find it necessary to put their animals on the market without proper finish because gains are impossible and loss in weight is common when the flies become numerous.

SUMMARY OF LIFE HISTORY

Like all other flies, this species has four stages in its life history—namely, the egg, larva, pupa, and adult.

The egg.—The eggs of this fly are elongate ovoid and of a creamy white color. They are about one twenty-fifth of an inch in length, and under a magnifying glass show a distinct furrow along one side. When placed on any moist substance they hatch in from 1 to 3 days after being deposited. In hatching a small slit is made around one end of the groove, and the minute maggot crawls out. Figure 1 shows four eggs on a piece of straw; the two at the right have hatched.

The larva, or maggot.—When first hatched the larvæ, or maggots, are about one-twelfth of an inch in length and, being translucent, are not easily seen with the naked eye. Development takes place fairly rapidly when the proper food conditions are available, and the growth is completed within 11 to 30 or more days. When full grown the larvæ (fig. 2) are pale yellow or nearly white and about four-fifths of an inch in length. They have the typical shape and action of most maggots of this group of flies. The hind end is large and the body tapers to the head. When exposed to the light the maggot quickly disappears in the straw or other matter in which it is breeding.

The pupa.—When the larvæ are full grown, they shorten and become thicker, and the skin contracts and hardens to form the case in which the transformation to the adult is to take place. This puparium, or pupal case (fig. 3), is rather soft and yellowish at first. but soon becomes harder and changes to reddish brown. It is elongate oval, slightly thicker toward the head end, and from one-sixth to one-fourth of an inch in length. During this stage the insect is completely dormant, the transformation from maggot to adult fly going on within the puparium. This resting stage requires from 6 to 20 days, or in cool weather considerably longer.

FIG. 2.—The stable fly: Larva, or maggot. Greatly enlarged

The adult.—When the fly has completed its development within the puparium it pushes its head against the end until the shell splits open. Then it crawls out as an adult fly, but so different from the fly ordinarily seen that one would scarcely recognize it. The color is pale and the head bulges out in front between the eyes. At this time the wings are only small wrinkled sacs. In a few minutes air is forced into the wings, and they unfold slowly, the fly becomes gradually darker in color, and its body becomes harder. Up to this time the beak is not visible, as it is bent downward between the legs. Soon it becomes almost black and is brought forward in its natural position so that the tip may be seen from above. When completely dried out the adults show four rather distinct, dark, longitudinal markings on the thorax, as well as several dark spots on the abdomen. The male usually is slightly smaller than the female, the body of which measures from one-fourth to five-sixteenths of an inch in length. The adult, as seen from above, is shown in Figure 4, and a side view of a female specimen engorged with blood is shown in Figure 5.

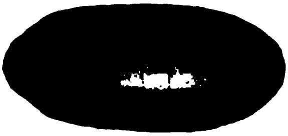

FIG. 3.—The stable fly: Pupa. Greatly enlarged

DEVELOPMENT AND HABITS

BREEDING PLACES

Horse manure has been considered the normal breeding medium for this pest. Investigations made during the outbreak in 1912 showed clearly, however, that the vast majority of the flies bred out in straw stacks, and investigations made around stables and barns indicate that while the fly breeds in pure horse manure it favors a mixture of this substance with straw. The fly was found to be breeding in much greater abundance in oat straw than in wheat straw. This appeared to be due to the softer stems and the greater amount of leaves in the oat straw, which furnished better food and allowed the stacks to become more compact. Rice straw was found to furnish suitable breeding conditions, and there is little doubt that barley and rye straw often serve as food for the immature stages.

It has been found by Professor Iches to breed in Argentina in great numbers in the débris left after threshing flax. A careful examination of portions of alfalfa stacks which were moist and readily accessible to numbers of flies showed that they were not infested, nor were accumulations of weeds and bunches of grass in open fields. The insect occasionally may breed in broken-up masses of hay or dead grass, especially when these are permeated with liquids from manure, and corn husks in feeding pens have been found to harbor the maggots.

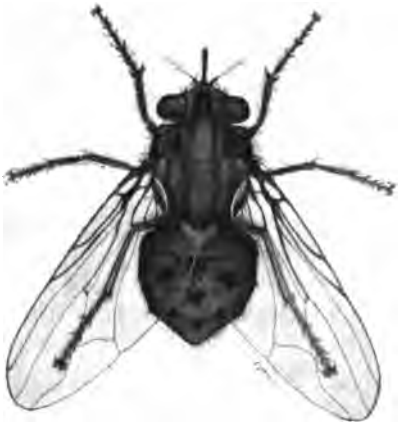

FIG. 4.—The stable fly. Adult as seen from above. Greatly enlarged

On some of the islands in the Great Lakes and along the Gulf and Atlantic coasts these flies are present in great numbers nearly every summer. It seems certain that they breed in accumulations of fermenting vegetation under such circumstances.

The manure piles commonly found near stables where horses are kept furnish suitable breeding conditions. This is especially true in the early spring, when the warmth of the manure appears to be very attractive to the flies for egg laying. Cow-lot manure which has become broken up, especially when mixed with waste feed, is utilized as a breeding place; and so is ensilage, particularly when mixed with straw, as is often the case when the bottom of a silo is cleaned out. Experimentally, a few specimens have been reared from pure cow manure, but this substance seems to be unattractive to the adult and not favorable for the breeding of the larvæ on account of its very compact texture.

The stable fly has never been found breeding in human excrement and does not frequent malodorous places, which are so attractive to the house fly; hence it is much less likely to carry typhoid and other germs which may be found in such places.

This insect develops somewhat more slowly than the house fly, and it is therefore more essential, in order that it may breed successfully, that the eggs be deposited in rather large accumulations of material. The larvæ are sensitive to drought and soon succumb if the material in which they are developing is not kept rather moist.

HABITS OF THE ADULT

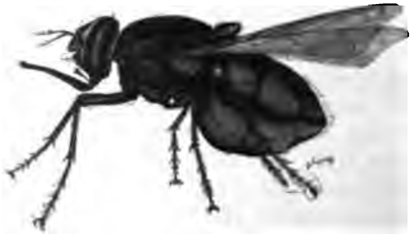

FIG. 5.—The stable fly: Adult female, side view, engorged with blood. Greatly enlarged

Both the male and female of this species feed on the blood of animals. They appear to discover their host mainly by sight and usually, especially on cattle, pass quickly to the lower portion of the legs, particularly on the outside, where the hair is somewhat shorter than on other parts of the animal and where they are less likely to be struck by the tail of the host. When the flies are very abundant their attack is by no means confined to the legs, as both cattle and horses have been seen practically covered with flies on all parts of the body. They seldom remain on the host long without inserting the beak. Before blood is extracted they are easily disturbed and often move about several times before settling down for final engorgement. After the beak is well inserted and the blood begins to flow they usually become engorged in from two to five minutes. The insertion of the beak is accompanied by a rather severe, sharp pain. This accounts for much of the worriment caused to the host. After blood extraction has begun little or no pain is felt. During feeding the abdomen becomes greatly distended (see fig. 5) and often of a distinctly reddish color. When satisfied the fly withdraws its beak and flies rather sluggishly to some near-by object, where it rests while digesting its meal. When the proboscis is withdrawn a drop of blood usually exudes from the wound. Numerous small flies have been seen to frequent the blood which exudes in this way, and it is not improbable that the screw-worm fly[4] may deposit its eggs on these spots and thus cause infestation of the host with these maggots.

During warm weather the blood is digested rapidly and the flies may feed again the same day. When the weather is cooler they usually require about a day for the digestion of the blood. After partaking of a meal the flies, during hot weather, ordinarily alight on the walls of buildings or on foliage of plants in shady situations. When the temperature is lower they remain in the sunlight, but in all cases they tend to avoid strong wind.

Adults frequently follow for considerable distances teams traversing roads and finally, when engorged, settle on near-by objects. Other teams which pass along the same highways are thus frequently attacked by flies which have completed the digestion of their previous meal, and this has given rise to the idea that the flies are breeding in weeds, grass, and hedges along the highways. This is also a means by which the flies invade territory beyond that in which they develop. Adults have been observed to travel many miles in the passenger coaches of railways. Few individuals are carried in this way, but doubtless the spread of the species is aided, and, what is more important, diseases might be spread in this way by infected flies.

Feeding may take place a number of times. Experimentally individual flies have been induced to engorge as many as 14 times. Flies have been observed to partake of water and to feed to some extent on succulent fruit. They feed commonly on the moisture on fresh manure and on rotting straw. Although man is bitten by these flies occasionally, horses and cattle seem to be preferred as hosts. Dogs are also severely attacked, especially on the ears, which are often denuded of hair and made practically raw by the numerous bites.

REPRODUCTION

Mating of the flies takes place while they are not on hosts, and egg laying soon follows, provided the flies have fed a sufficient number of times. It seems that at least three feedings on blood are necessary for the production of eggs. After the third meal is digested the flies seek suitable places for oviposition. When the weather is cool additional feedings are often necessary before eggs are produced. The adults appear to have a keen sense of smell and are able to detect moist straw and suitable manure very quickly. This is especially noticeable when a straw stack which is dry on the outside is opened up so as to expose the moist and rotting interior.

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[4] **Known scientifically as *Cochliomyia macellaria* Fab.**

Very soon after a stack is opened flies are seen to come to the moist straw in numbers and begin depositing eggs. Usually they crawl into the loose straw, sometimes going to a depth of several inches. When laying eggs the fly greatly extends the ovipositor and uses it as an organ of touch in locating a suitable spot. The eggs are laid in irregular masses, although occasionally single ones are deposited. The female usually moves several times during oviposition so that each egg mass contains from a few to as many as 25 or more eggs. The greatest number of eggs which has been observed to be deposited before another meal of blood is taken is 122. After all of the eggs have been deposited the female again seeks a host, and this feeding is again followed by egg laying. Three or more of such ovipositions commonly take place in this species. It is sometimes necessary, especially during cool weather, for a fly to become engorged twice before each oviposition following the first. The greatest number of eggs which has been seen to be deposited by a single female during her life is 632.

LENGTH OF LIFE OF THE ADULT

A knowledge of the length of life of the adult is important in determining its possibilities as a disease carrier and annoyer of animals. Individuals kept in small tubes without food or water during hot weather died within 2 days. When water and sugar sirup were supplied to flies, in a screen cage about 1 foot square, one specimen out of a large number of males and females lived for 23 days. Individuals which had access to blood at frequent intervals lived 17 days, and a few specimens, among a considerable number which were kept in large cages with cattle and suitable material in which to deposit eggs, lived for 29 days. During cool weather the length of life is still greater. Under more abnormal conditions other investigators have kept individuals alive more than three months.

THE LARVA AND ITS HABITS

The larvæ, or maggots, begin feeding as soon as they hatch from the eggs and continue to do so throughout their growth. Portions of moist straw or other material in which they are breeding are torn off by their mandibles, which are located on the narrow or head end of the maggot. When very small they frequently penetrate between the layers of the stalk or leaves of grain when moistened in the straw stack. When larger they often feed within the straws, and transformation to the resting state sometimes takes place in this protected situation.

The larval period lasts from 11 to 30 days, and during very cold weather probably considerably more than a month. The character and abundance of food and the amount of moisture have an important influence on development, and larvæ follow the moisture inward as the material in which they are breeding becomes dry on the surface. Pupation occurs anywhere in the breeding material; it frequently happens, however, that the larvæ, when in small masses of straw or manure, work downward as the material dries and pupate at the surface of the soil.

LIFE CYCLE

Complete development from the deposition of the egg to the emergence of the adult fly may take place in 19 days, or even in 14 days, according to some investigators. The developmental period, however, usually ranges from 21 to 25 days where conditions are favorable. Forty-three days is the longest period observed, although it is certain that in the late fall and during the winter months a much longer period is often necessary. The finding of full-grown larvæ and pupæ in straw during the latter part of March, 1913, in northern Texas shows that development may require about three months, as these stages almost certainly developed from eggs deposited the previous December.

HIBERNATION

In the southern part of the United States there is no true hibernation of this insect. Adults have been found to emerge from their breeding material at various times during the winter when temperatures were not low. It is doubtful if adults appearing under these conditions ever lay eggs. The individuals which pass the winter successfully hatch from eggs laid in the fall and continue development slowly during the winter, emerging in early spring when the temperatures are favorable for reproduction. In the northern part of the United States few flies emerge during the winter months, this period being passed normally in the larval and pupal stages.

AGRICULTURAL PRACTICES IN RELATION TO FLY ABUNDANCE

Certain agricultural practices favor greatly the development of the stable fly. As has been stated, this species breeds most commonly in straw and horse manure or in a mixture of these two substances. The custom of allowing the manure from the horse stable to accumulate just outside of the stable doors insures the presence of stable flies at all times when climatic conditions are suitable for breeding. Allowing barnyards, especially around dairies, to become knee-deep in manure is also calculated to produce flies in abundance.

In the grain belt it is the practice of farmers to thresh the grain in the fields by means of self-stacking threshing machines. The individual stacks cover much ground, and the straw is very loosely piled. In many cases for convenience several stacks are formed in various parts of a field. When threshing is followed by heavy summer and fall rains this loosely piled straw is certain to form a breeding place for great numbers of flies. This is precisely what occurred in 1905, 1912, and 1926, when there were serious outbreaks of the stable fly in Texas. In many instances straw stacks are not protected from livestock. The animals soon scatter the straw and by adding manure still further favor fly breeding. These straw stacks usually are allowed to remain throughout the fall and winter without attention. When the succeeding crop is planted the area occupied by the stacks is simply left uncultivated. In a few cases stacks are burned in the spring, but frequently they are left from year to year and the new straw added to the old stacks, destruction only taking place when the stacks become exceedingly large.

It will be seen that these practices not only encourage the breeding of the stable fly, but when the straw becomes sufficiently rotten and compact the house fly as well breeds in it in abundance. Throughout the grain belt a very considerable amount of valuable land is thus left untilled and the full manurial value of the straw is lost. That the stacks serve some purpose as shelter and feed for livestock kept in the fields during winter is the only legitimate reason for not scattering them or burning them in the late summer or fall.

NATURAL CONTROL

CLIMATIC EFFECT

The flies feed when the temperature is very high and the sun bright and hot as well as during cool and cloudy weather. They have been observed to attack animals during drizzling rain, and when somewhat protected by sheds and stables they often feed during heavy rain. The lowest temperature at which flies have been observed to partake of blood was 55° F. When the temperature goes below 60° F. their desire to feed is less marked. Between 40° and 48° F. they lose their ability to fly, and complete inactivity occurs when the temperature ranges between 31° and 45° F. This range of activity is due to variation in individual flies, to the rapidty of the decline or rise in temperature, and to the minimum temperature experienced by the individuals. No flies appear to be killed by a temperature not lower than 27° F., and some at least are able to survive temperatures considerably below this point. All flies at Dallas, Tex., seem to have been killed when the temperature reached 8° F. As has been stated, the flies always seek shady places during hot weather, but when the temperatures are lower they delight to dart about in the sun in a manner very similar to that of the house fly.

The maggots, or larvæ, are very susceptible to drying. This is particularly true soon after they have hatched. Excessive moisture also is detrimental to their development, and flooding kills them in a few hours. They appear to be able to endure rather high temperatures when abundant moisture is at hand, although the heat produced in manure and straw stacks is often sufficient either to kill them or to drive them outward. No doubt the generation of heat within the breeding places stimulates the development of the immature stages during the fall and winter months. Light is detrimental to the development of the larvæ. When placed in bright daylight, even though sheltered from the sun, larvæ have never been known to complete development. These facts make it possible to destroy the pest in this stage of its life.

The pupæ of the insect, being inactive and protected, are much less susceptible to all climatic extremes. They appear to be able to withstand low temperatures and are not very susceptible to heat or drying, especially after development of the fly has proceeded for some time.

PREDATORY ENEMIES

Hogs, as well as chickens and other poultry, are capable of destroying great numbers of the immature stages of the stable fly. They are attracted to the straw stacks and manure piles partly by the grain, and incidentally they destroy the maggots and pupæ which they find. Several kinds of insects are important destroyers of these stages. Certain beetles devour them in considerable numbers. The adult flies fall prey to numerous enemies. Among the more important enemies of the adults are the large robber flies, which may be seen in great numbers around straw stacks, pouncing upon stable flies which are depositing eggs or resting upon straw. Wasps of several kinds capture the flies that are attacking stock or flying about. When filled with blood the flies are comparatively sluggish and much more easily caught by these enemies, and spiders often devour them.

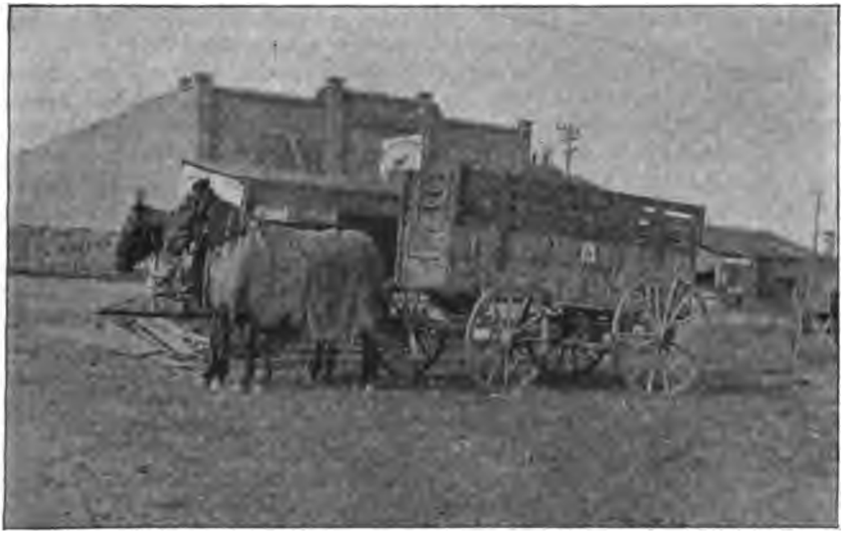

FIG. 6.—Burlap covering used to protect horses from the stable fly

PARASITIES

Two species of small wasplike insects have been found to breed within the pupæ of the stable fly. These insects deposit their eggs through the hard puparium, and instead of an adult stable fly the little parasite emerges. In some cases, where the immature stages of the fly were concentrated in great numbers, as many as 40 per cent of the pupæ were found to have been destroyed by these parasites. At least one of the parasites[5] has a wide distribution in this country.

ARTIFICIAL CONTROL

As is the case with most insects, the destruction of the stage which is actually doing the injury is most desired by those concerned. With this species, as with many others, this is very difficult, and some more easy way of securing the desired end must be determined. With the stable fly the natural point of attack is found in the immature stages, and there is every reason to believe that by properly caring for substances in which it breeds the insect may be kept well under control.

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[5] *Spalangia muscidarium* Richardson.

PROTECTION OF LIVESTOCK FROM ATTACK OF THE STABLE FLY

When adult flies are present in great numbers it is necessary to devise some means of protection against them, especially since we know that every individual is capable of feeding a number of times before it dies. Most of the materials used with a view to repelling the flies from livestock have been found to be ineffective and, although some gave a measure of protection for a time, none had a lasting effect. In addition to the temporary value of these substances, in many cases injury was produced by their application, especially if persisted in often enough to keep the flies away. These facts emphasize the importance of taking steps to prevent fly breeding rather than depending on protection of the stock against the flies.

Many malodorous mixtures, particularly of an oily nature, have some value as repellents, but in preparing these care should be taken that they are not made too strong, particularly when animals are being worked in the hot sun, as they are likely to cause overheating and often produce shedding of the hair. A mixture of fish oil (1 gallon), oil of pine tar (2 ounces), oil of pennyroyal (2 ounces), and kerosene (½ pint) was found to be fairly effective in keeping the flies off of livestock for a short time when applied lightly, but thoroughly, to the portions of animals not covered with blankets or nets. Kerosene extract of pyrethrum is a very good spray for killing the flies, but the proprietary sprays of this class are rather expensive.

Work animals may be largely protected from the pest by means of coverings. One type of covering which has been found very effective and inexpensive consists of a blanket made of double thickness of burlap so arranged as completely to cover the back, sides, and neck of the animal (fig. 6). The legs also are then sometimes covered by means of old trousers slipped on over the feet and tied over the back. Leather nets or strips of leather attached to the bridle also aid in keeping the flies from the head. The ordinary fly net has been found to be of little value as it only tends to displace the flies temporarily and cause them to settle in places not covered by the net.

Completely darkened stables offer much protection from the flies, although the resulting lack of ventilation is objectionable. The thorough screening of all windows and doors is much more desirable. When screened barns are used, care should be taken to brush the flies from the animals, when they are about to enter, by means of nets over the doorway, or with sacks. The flies which gain entrance to the barn may be killed by spraying with kerosene-pyrethrum extract. Little can be done to protect range stock from the flies. On hog farms a freshly plowed trench offers considerable protection to the swine. The sides of the trench may be smeared with petroleum, which is rubbed off on the animals and acts as a repellent. The trench may be used also for protecting sheep, but the petroleum in their case is unnecessary.

TRAPPING THE FLIES

It is impossible successfully to capture adult flies by means of the traps ordinarily used for the house fly. A trap has been designed by Prof. C. F. Hodge, however, which may be utilized in capturing adults as they enter or leave barns. This trap (figs. 7, 8, 9) is undoubtedly very effective under certain conditions and has the advantage of catching not only the stable fly but the house fly and other obnoxious species. In order to employ the trap for the stable fly, it should be built in a frame so as to fit closely in a window, preferably on the brightest side of the barn and close to the cows or horses kept within. Other windows should be darkened by hanging gunny sacks over them. This may be done so as not to interfere with ventilation, and by flapping in the wind and darkening, both drive and cause flies to be attracted to the light-trap window.

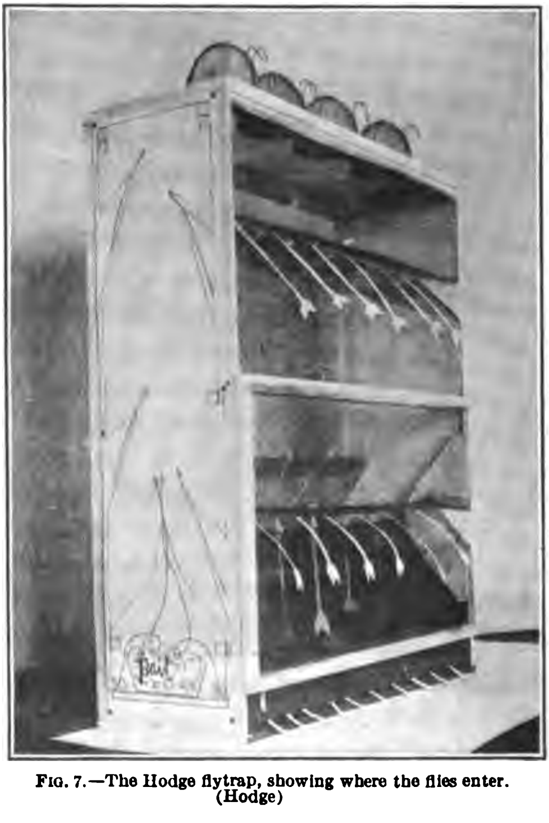

FIG. 7.—The Hodge flytrap, showing where the flies enter. (Hodge)

At the bottom of the trap a space about one-fourth of an inch wide running entirely across the window is left on both sides of the frame. This crack admits the flies beneath a roof or ridge of screen wire having holes large enough for flies to go through punched along its top at 2-inch intervals. To capture the house flies, bait consisting of any material attractive to them is placed in pans beneath this ridge. The flies enter this space, ascend through the holes, and are unable to escape. The sides of the trap, also, are made of ordinary screen wire bent inward and upward in two horizontal folds running across the window, one toward the bottom and one toward the top. The ends of the screen are then securely tacked and a series of small holes punched along the inner edge of each of the folds. The flies, in trying to go in and out through the window, crawl into the folds and enter the holes at the apex, but never escape, as on the inside the holes are along the projecting ridge. Prof. Hodge states that a trap set in a window in a basement barn near a cow within caught nearly 5 quarts of flies from July 1 to November 1. The stable fly constituted 90 per cent of these flies.

This trap is inexpensive and can be made by anyone with a box, or box lumber, and screen wire. It is especially well adapted to well-made barns where the flies do not have numerous places for entrance and exit. It is also more applicable to small barns in which animals are kept more or less constantly than to large dairy barns where the cows are brought in only at milking time. Under the latter conditions the flies enter the barns on the cows and many remain on the walls of the barn until after the cattle have been turned out. In some cases where flies are concentrated in dairy barns in this manner they have been driven out by forcing live steam into the building from the boilers used for sterilizing purposes. Where such arrangements are made the flies may be caught in such traps as the one described, as they are endeavoring to escape from the barn, which should first be tightly closed.

If such barns are tightly closed, as above, during the light part of each day and the windows without traps darkened, practically all the flies will "catch themselves" in trying to escape through the trap-window or windows. Many, however, prefer to use sprays to kill the flies within barns.

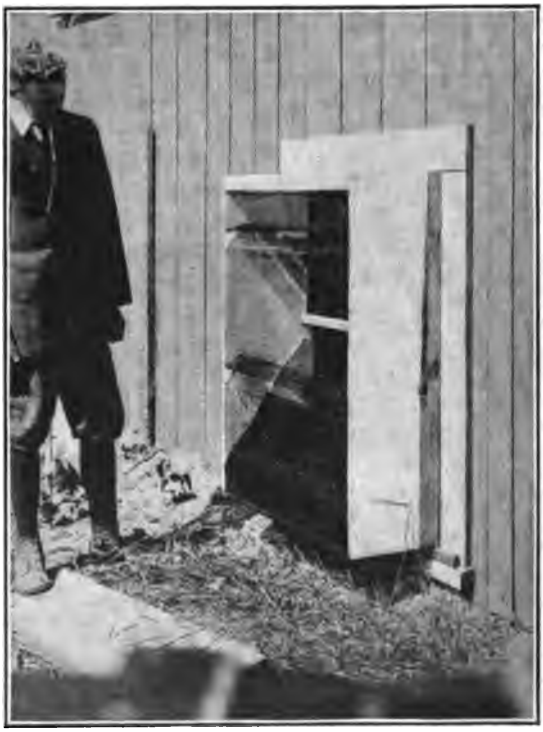

FIG. 8.—The Hodge flytrap fitted to a barn window. (Hodge)

DESTRUCTION OF IMMATURE STAGES AND PREVENTION OF BREEDING

Since straw stacks have been found to be the principal breeding places of this insect in the grain belt, the proper care of the straw is by far the most important step in control. When the straw is to be kept for protection and food for livestock, it should be stacked with more than ordinary care. The sides of the stack should be made nearly vertical and it should be rounded up well on top, the better to shed the rain. With blower stackers a very satisfactory stack can be put up by controlling the blower and keeping one or two men on the stack. This method is shown in Figure 10. After the stack is complete it is advisable to clean up around its base and to scatter or burn the loose straw and chaff.

So far as possible, all straw which is not required for winter feed for stock should be disposed of immediately by scattering it over the land soon after threshing and subsequently plowing it under, or by burning the stacks. The plowing under of the straw which can not be used for feed is the most advisable procedure in regions where the moisture is sufficient to cause it to rot rapidly. Oat straw is most generally used for feeding purposes, and this straw forms the principal breeding ground for flies. It is therefore important in regions where rainfall is heavy that all oat straw needed for feed or bedding be baled and stored under cover and that the remainder be promptly burned or scattered. In the drier sections of the country proper stacking of the straw may be depended upon for its preservation.

All straw stacks not consumed by stock during the winter should be promptly disposed of in the early spring, as these stacks furnish flies continuously during spring and summer. Often the flies reared in such situations are abundant enough to cause great annoyance to livestock during early spring, and by multiplying throughout the summer an almost incredible number are produced by fall.

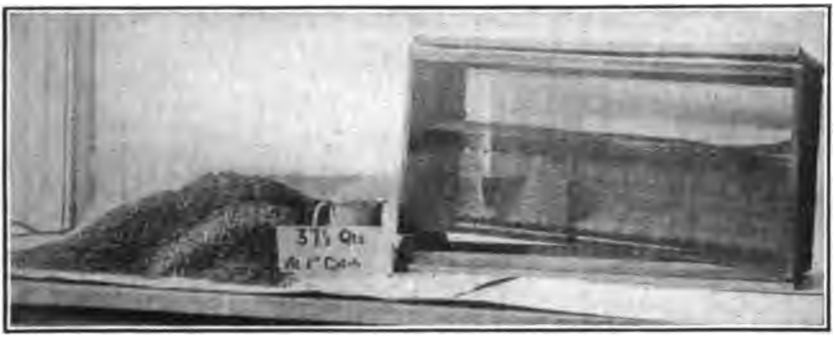

FIG. 9.—Pile of flies caught in a Hodge flytrap. (Hodge)

The conditions—that is, the heavy rainfall on the freshly threshed straw—which have produced most of the severe outbreaks render the straw largely unfit for feed for livestock, as the stacks in many cases are wet through and soon become heated and rotten. In such instances, where the flies are already breeding in these stacks, their immediate destruction by burning or scattering is necessary to relieve the conditions. When stacks are scattered the work should be done thoroughly, so as to expose the straw completely to the influence of the sun, wind, and light. By this procedure practically all of the larvæ and many of the pupæ are destroyed. Straw spreaders are on the market which are said to give satisfaction.

It is best to plow under the scattered straw soon after it has become well dried out. In many sections of the grain belt plowing is not generally practiced, the land being simply disked prior to seeding. The scattering of straw over the ground in such cases is less practicable than where the land is plowed; hence wherever plowing can be done it should be adopted.

In sections of the country where headers instead of binders are used, and consequently a smaller amount of straw is accumulated, the straw is much more easily disposed of by the methods just outlined. The use of combined harvesters and threshers solves the problem of the straw stack, for by this method the straw and chaff are left distributed over the fields.

The use of poisons or other substances, with a view of destroying immature flies in straw stacks, is neither practicable nor advisable. Enormous quantities of these materials would be required to permeate the straw to kill the larvæ, and, even though they were destroyed, the straw would be rendered dangerous to livestock.

Although straw is the principal breeding place for stable flies within the grain belt, there is no doubt that thousands of them develop in manure piles. Moreover, such material is utilized extensively as a breeding place for the house fly and horn fly. Hence the proper care of all sorts of animal refuse is essential for successfully combating the pest. Manure should be hauled out and scattered at regular intervals, preferably every three days, as is recommended for the control of the house fly, and any accumulations of straw or hay, especially adjacent to stables, should be disposed of, as these are often utilized for the breeding of the stable fly when larger accumulations of horse manure and straw are not available.

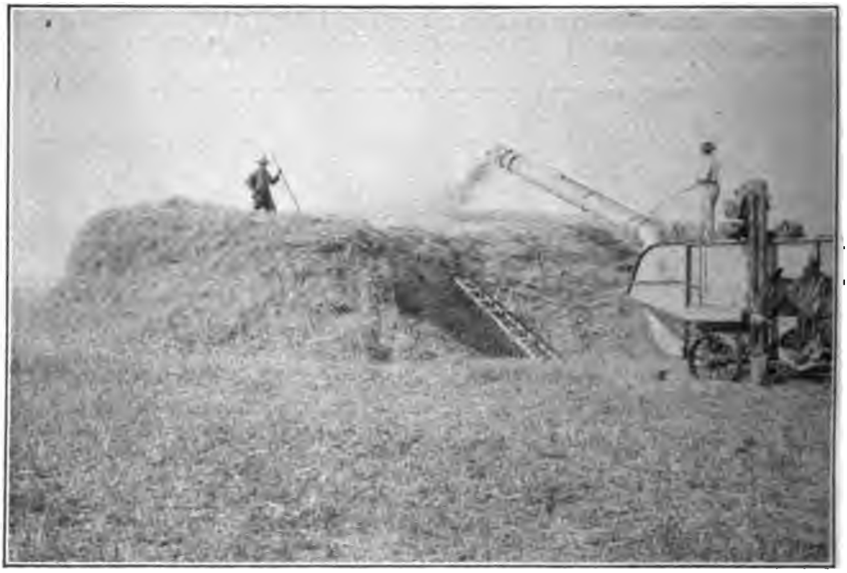

FIG. 4.—Stacking straw to prevent stable fly breeding

Manure boxes provided with a trap on top to catch the flies which breed out (fig. 11) prove very satisfactory for farms with a few head of stock. The box should be as nearly fly-proof as possible and the manure put into it at least every four days so as to catch the house flies as well as stable flies.

Manure pits properly screened and with flytraps provided are adaptable to use on dairy farms, and the maggot trap described in Farmers' Bulletin 851 will destroy many stable-fly maggots as well as those of the house fly.

A large percentage of stable-fly larvæ as well as larvæ of the house fly may be destroyed in manure by treating it with hellebore or borax. The former is used by soaking one-half pound of hellebore in 10 gallons of water for 24 hours and sprinkling this quantity over each 8 bushels of manure. The borax, used in powdered form at the rate of 1 pound to each 16 cubic feet of manure, is scattered over the pile and sprinkled with water. Neither of these substances will injure the fertilizing value of the manure if used in the quantities indicated and if not over 15 tons of the treated manure is applied per acre.

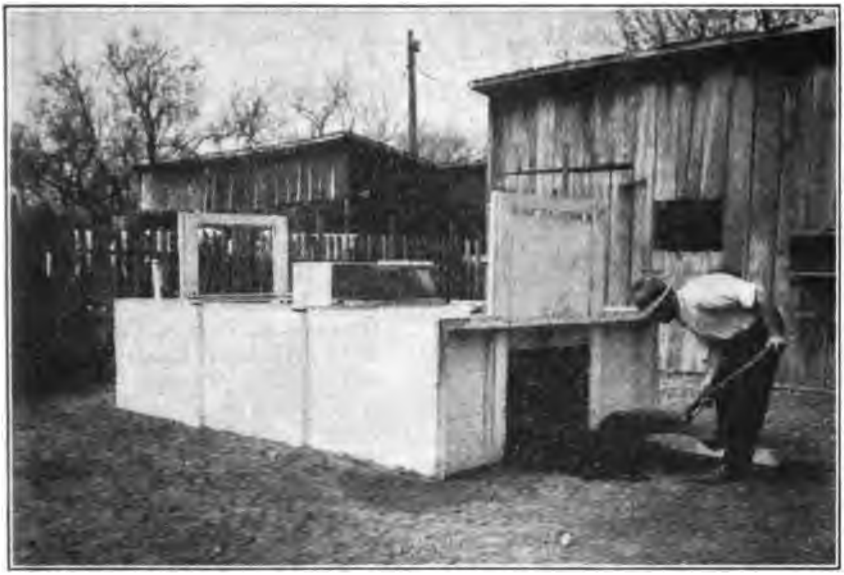

FIG. 11.—Manure box with flytrap attached

The need of properly caring for stable refuse is still further emphasized by the fact that there are far more manure piles than straw stacks. Furthermore, the stable manure is usually in close proximity to the habitations of man and thus furnishes flies, which have freer access to man, with consequent greater potentiality as disseminators of human diseases.

MEDICATED SALT VALUELESS

Certain medicated salts, most of which contain sulphur and common salt, have been placed on the market. The claim is made that their use in lieu of common salt will protect stock from flies. Such materials are entirely valueless against flies.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

December 23, 1927

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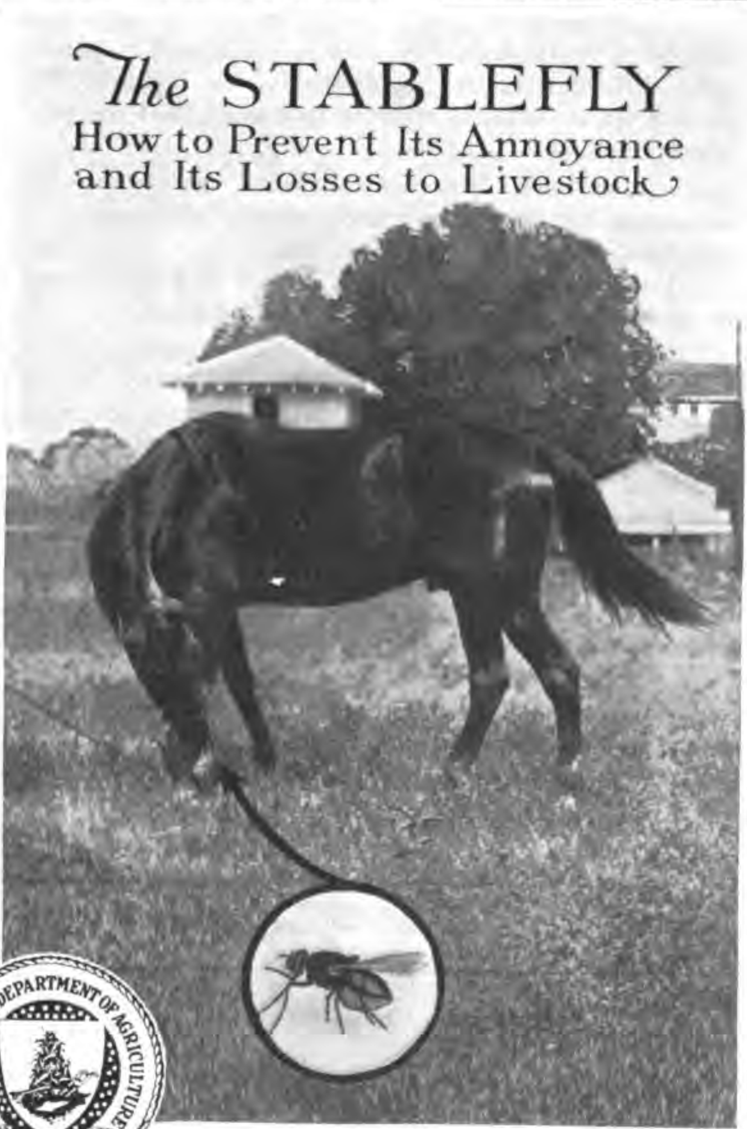
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1097

The STABLEFLY

How to Prevent Its Annoyance and Its Losses to Livestock



THE ACUTE PAIN produced by the insertion of the proboscis of the stablefly brings to any man a sudden realization that this biting insect is pointedly different from the housefly, or typhoid fly, even if until then his opinion had been that the two were identical.

At times this fly becomes excessively abundant and occasions heavy losses among nearly all classes of livestock. Year in and year out it is a source of great annoyance, especially to horses and cattle, and is an all-too-common and persistent pest.

The adult stablefly resembles the housefly, but is slightly broader and feeds principally on the blood of animals, which it draws with its long, piercing mouth parts. It breeds in accumulations of various kinds of vegetable matter and also in manure, especially when the latter is mixed with straw. When strawstacks become wet soon after threshing the flies breed in the fermenting straw, and it is these conditions that produce the severe outbreaks.

Spraying animals with repellents is not very satisfactory, but the numbers of stableflies can be kept down by caring properly for stable refuse and by stacking or otherwise disposing of the straw.

This bulletin is a revision of and supersedes Farmers' Bulletin 540, The Stable Fly.

Washington, D. C. **Issued April 1920; revised October 1939**

THE STABLEFLY: HOW TO PREVENT ITS ANNOYANCE AND ITS LOSSES TO LIVESTOCK

By F. C. Bishopp, *principal entomologist, Division of Insects Affecting Man and Animals, Bureau of Entomology and Plant Quarantine*

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A TORMENTING AND INJURIOUS PEST

THE STABLEFLY,[1] or stock fly, is one of the most important sources of annoyance to livestock throughout the United States. When present in small numbers it has no apparent injurious effect, but on frequent occasions conditions arise which permit its development in enormous numbers, and at such times the injury to all classes of livestock becomes marked.

In addition to being a source of annoyance to domestic animals, the stablefly, when present in large numbers, has a deleterious effect upon them owing to the quantity of blood drawn, and animals not infrequently are so reduced in vitality as to permit certain diseases to become acute and cause their death. In Africa and other parts of the world this fly is capable of transmitting certain serious maladies of horses and camels. In our country it probably plays a part in the dissemination of anthrax, and investigations indicate that the disease of horses known as swamp fever or infectious anemia is carried by it. Work thus far conducted indicates that the fly acts solely as a mechanical carrier, passing these diseases directly from one animal to another in biting.

In addition to its role as a livestock pest, the stablefly is important as an annoyer of man, and there is some indication that it is concerned, in part at least, with the transmission of certain diseases of man, most notable of which is infantile paralysis.

THE COMMON NAMES OF THE INSECT AND HOW IT MAY BE RECOGNIZED

"Stablefly" is not entirely satisfactory as a common name for this pest, as it is frequently abundant in open fields and along roadways and is not uncommonly encountered about the house. Nevertheless it is found about stables more frequently than anywhere else. In certain localities such names as "stablefly," "stock fly," "dog fly," "wild fly," "straw fly," and "biting housefly" are applied to it.

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[1] Known scientifically as *Stomoxys calcitrans* (L.).

As the last name suggests, this insect is frequently confused with the housefly.[2] The common housefly is not capable of biting, its mouth parts being soft and broad on the tip. On the other hand, the stablefly has mouth parts well fitted for piercing the skin of animals and sucking blood. The presence of such biting mouth parts, therefore, distinguishes it at once from the housefly. The tip of the beak can be seen protruding from beneath the front of the head when the fly is at rest. (See figs. 4 and 5.) The insect is usually slightly larger than the housefly and more robust. It usually alights upon an animal with the head directly upward, while another insect sometimes confused with it, the horn fly,[3] rests with its head downward, and the housefly may assume various positions and moves much more frequently. The horn fly is much smaller than the stablefly, the wings are widely spread at the tips, and it is usually present on cattle only, where it occurs in small swarms, moving from one part of the animal to another when disturbed.

DISTRIBUTION AND ABUNDANCE

The stablefly is very widely distributed throughout the world. In fact it seems to have followed man and his domestic animals to all quarters of the globe. It becomes more abundant, however, in the temperate regions, such as the United States and Argentina. In the United States it is found everywhere, but within the confines of this country its abundance varies considerably.

Serious annoyance to livestock is most common in the Central States from Texas to Canada, where grain is grown extensively. Reports indicate that it may be important occasionally in various other sections and is a more or less persistent pest in all irrigated regions.

From time to time exceedingly severe outbreaks of this insect occur. One of the worst of these took place in 1912. Injury in northern Texas and in Oklahoma during the late summer and early fall of that year was unprecedented. The pest was abnormally numerous throughout the entire grain belt, including the southern portions of central Canada. Since 1912 the insect has appeared in great numbers on several occasions, but these outbreaks have not been so widespread.

This fly appears not infrequently on warm days during the winter and early spring in the Southern States, but seldom does it become sufficiently abundant in any part of this country to cause annoyance before early summer. It nearly always increases in abundance and injury is most acute during August and September.

CHARACTER OF INJURY AND LOSSES

Practically all warm-blooded animals are attacked by the stablefly, but some domestic species are much freer from injury than others. This comparative freedom is due largely to protection afforded by the hair of the host or by some of its habits. Mules, horses, cattle, hogs, dogs, cats, sheep, and goats are subject to attack in about the order named. The distress caused individual animals varies greatly with their temperament.

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[2] Known scientifically as *Musca domestica* L.

[3] Known scientifically as *Haematobia irritans* (L.).

As has been indicated, this fly is of importance in a number of ways. There is little doubt that it is a potent factor in disease transmission, although actual proof of this has been secured in the case of a few diseases only.

Aside from conveying disease, this insect is of much importance on account of the worry produced by its bites. During severe outbreaks this is probably the most important cause of losses. In periods of great abundance all livestock are compelled to keep up a constant fight against flies from early morning until dark. At such times the flies are present not only around barns but in towns, cities, and open fields. Animals that are being worked in fields or on the streets and those kept in stables suffer alike. During severe outbreaks many horses and cattle become so weak that they give up the fight against the pest, and the flies swarm over them in countless numbers. In a few cases, where the animals are not promptly protected from attack, they succumb in a short time.

The loss of blood during severe outbreaks is an important consideration. When the fly is fully engorged, the abdomen is greatly distended, and it has been found that the blood extracted at one feeding is soon digested and the fly is ready for another meal. Thus animals continually exposed must serve to engorge thousands of individuals each day, each of the flies ingesting several drops of blood during a meal.

In the part of the United States where Texas fever occurs, in addition to the livestock actually killed by harassment and loss of blood, a considerable number of cattle are lost from Texas fever. In most of these animals, although the disease organisms are latent in the blood, no apparent injury would result under conditions favorable to livestock. Under the strain of continually fighting the flies and with the weakened condition brought about by the loss of blood, however, an acute form of Texas fever is induced. When animals begin to suffer from the fever they are less energetic in fighting the flies and consequently become the more ready victims.

During severe outbreaks the milk supply in fly-infested zones is much reduced. In the worst of these outbreaks dairymen find that the output of milk declines 40 to 60 percent and that in some cases cows are completely dried. For several months after the pest is abated the effects of the outbreak are apparent in lower milk production. Even in cows that freshen several months after an outbreak the effect on the yield of milk is said to be apparent.

During outbreaks all animals in the fly zone are reduced in flesh. In many cases cattle that had been fat enough for market are so lean that they cannot be sold advantageously. Horses and mules in many cases lose from 10 to 15 percent in weight. Some dairy herds that are usually shown at fairs suffer such marked injury that they are not fit to be exhibited.

In many cases the joints of both horses and cattle become so swollen and stiff from standing in water to avoid the flies that the animals can scarcely walk. Incessant stamping also injures their feet and joints.

Another source of loss to farmers is their inability to proceed with the usual farm plowing and other operations at the proper time. In many sections the flies annoy the horses so much that they cannot stand both the work and fighting off the flies. Some men work their horses at night in an effort to eliminate the attacks, but this is too severe for the teams, as the flies have allowed them no rest during the day. Numerous instances of horses becoming frantic from irritation are recorded. These often result in runaways and their attendant damage. Animals that are not being worked sometimes are injured by running into barbed-wire fences in endeavoring to escape the flies.

Along the Gulf and Atlantic coasts, particularly in western Florida, this pest frequently becomes extremely annoying to men and livestock late in the summer and in the fall. The flies often attack people on the beaches so violently as to drive them to cover; and vacationists naturally leave the affected areas when such hordes of flies appear.

In the Corn Belt, where many cattle are fattened, the stablefly is a source of great loss. Feeders frequently find it necessary to put their animals on the market without proper finish because gains are impossible and loss in weight is common when the flies become numerous.

SUMMARY OF LIFE HISTORY

Like all other flies, this species has four stages in its life history—namely, the egg, larva, pupa, and adult.

The egg.—The eggs of this fly are elongate ovoid and of a creamy white color. They are about one twenty-fifth of an inch in length and under a magnifying glass show a distinct furrow along one side. When placed on any moist substance they hatch in from 1 to 3 days after being deposited. In hatching a small slit is made around one end of the groove, and the minute maggot crawls out. Figure 1 shows four eggs on a piece of straw.

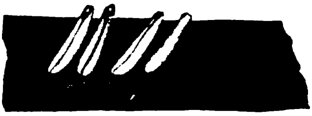

FIGURE 1.—Eggs of the stablefly attached to a straw. Greatly enlarged.

The larva, or maggot.—When first hatched, the larvae, or maggots, are about one-twelfth of an inch in length and, being translucent, are not easily seen with the naked eye. Development takes place fairly rapidly when the proper food is available, and the growth is completed within 11 to 30 or more days. When full-grown the larvae (fig. 2) are pale yellow or nearly white and about four-fifths of an inch in length. They have the typical shape and action of most maggots of this group of flies. The hind end is large, and the body tapers to the head. When exposed to the light the maggot quickly disappears in the straw or other matter in which it is developing.

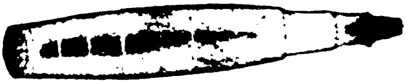

FIGURE 2.—The stablefly: Larva, or maggot. Greatly enlarged.

The pupa.—When the larvae are full-grown, they shorten and become thicker, and the skin contracts and hardens to form the case in which the transformation to the adult is to take place. This puparium, or pupal case (fig. 3), is rather soft and yellowish at first but soon becomes harder and changes to reddish brown. It is elongate oval, slightly thicker toward the head end, and from one-sixth to one-fourth of an inch in length. During this stage the insect is completely dormant, the transformation from maggot to aduly fly going on within the puparium. This resting stage requires from 6 to 20 days, or in cool weather considerably longer.

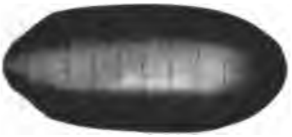

Figure 3. — The stablefly: Pupa. Greatly enlarged.

The adult.—When the fly has completed its development within the puparium it pushes its head against the end until the shell splits open. Then it crawls out as an adult fly, but so different from the fly ordinarily seen that one would scarcely recognize it. The color is pale, and the head bulges out in front between the eyes. At this time the wings are only small wrinkled sacs. In a few minutes air is forced into the wings, and they unfold slowly, the fly becomes gradually darker in color, and its body becomes harder. Up to this time the beak is not visible, as it is bent downward between the legs. Soon it becomes almost black and is brought forward in its natural position so that the tip may be seen from above. When completely dried out, the adults show four rather distinct, dark, longitudinal markings on the thorax, as well as several dark spots on the abdomen. The male usually is slightly smaller than the female, the body of which measures from one-fourth to five-sixteenths of an inch in length. The adult, as seen from above, is shown in figure 4, and a side view of a female specimen engorged with blood is shown in figure 5.

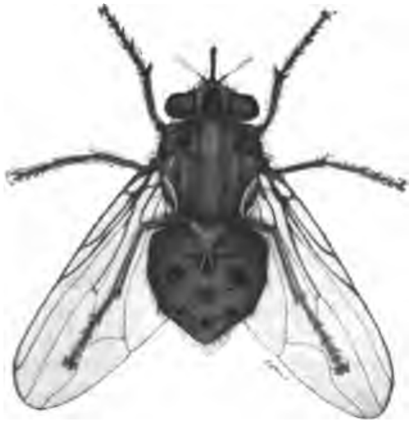

Figure 4.—The stablefly. Adult as seen from above. Greatly enlarged.

DEVELOPMENT AND HABITS

BREEDING PLACES

Horse manure has been considered the normal breeding medium for this pest. Investigations made during the outbreak in 1912 showed clearly, however, that the vast majority of the flies bred out in strawstacks, and investigations made around stables and barns indicate that while the fly breeds in pure horse manure it favors a mixture of this substance with straw. The fly was found to be breeding in much greater abundance in oat straw than in wheat straw. This appeared to be due to the softer stems and the greater amount of leaves in the oat straw, which furnished better food and allowed the stacks to become more compact. Rice straw was found to furnish suitable breeding conditions, and there is little doubt that barley and rye straw often serve as food for the immature stages.

This fly has been found by Professor Iches to breed in Argentina in great numbers in the debris left after threshing flax. A careful examination of portions of alfalfa stacks which were moist and readily accessible to numbers of flies showed that they were not infested, nor were accumulations of weeds and bunches of grass in open fields. The insect occasionally may breed in broken-up masses of hay or dead grass, especially when these are permeated with liquids from manure, and corn husks in feeding pens have been found to harbor the maggots.

On some of the islands in the Great Lakes and along the Gulf and Atlantic coasts these flies are present in great numbers nearly every summer. It seems certain that they breed in accumulations of fermenting vegetation under such circumstances. The principal breeding place is probably in windrows of seaweed deposited at a favorable height above the water.

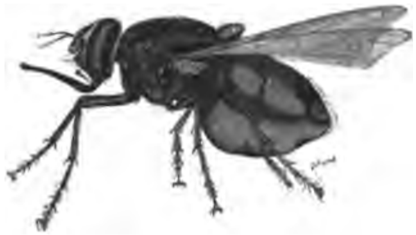

FIGURE 5.—The stablefly: Adult female engorged with blood, side view. Greatly enlarged.

The manure piles commonly found near stables where horses are kept furnish suitable breeding conditions. This is especially true in the early spring, when the warmth of the manure appears to be very attractive to the flies for egg laying. Cow-lot manure which has become broken up, especially when mixed with waste feed, is utilized as a breeding place; and so is silage, particularly when mixed with straw, as is often the case when the bottom of a silo is cleaned out. Experimentally, a few specimens have been reared from pure cow manure, but this substance seems to be unattractive to the adult and not favorable for the breeding of the larvae on account of its very compact texture.

The stablefly has never been found breeding in human excrement and does not frequent malodorous places, which are so attractive to the housefly; hence it is much less likely to carry typhoid and other germs which may be found in such places.

This insect develops somewhat more slowly than the housefly, and it is therefore more essential, in order that it may breed successfully, that the eggs be deposited in rather large accumulations of material. The larvae are sensitive to drought and soon succumb if the material in which they are developing is not kept rather moist.

HABITS OF THE ADULT

Both the male and female of this species feed on the blood of animals. They appear to discover their host mainly by sight and usually, especially on cattle, pass quickly to the lower portion of the legs, particularly on the outside, where the hair is somewhat shorter than on the other parts of the animal and where they are less likely to be struck by the tail of the host. When flies are very abundant their attack is by no means confined to the legs, as both cattle and horses have been seen practically covered with flies on all parts of the body. They seldom remain on the host long without inserting the beak. Before blood is extracted they are easily disturbed and often move about several times before settling down for final engorgement. After the beak is well inserted and the blood begins to flow they usually become engorged in from 2 to 5 minutes. The insertion of the beak is accompanied by a rather severe, sharp pain. This accounts for much of the worriment caused to the host. After blood extraction has begun little or no pain is felt. During feeding the abdomen becomes greatly distended (fig. 5) and often of a distinctly reddish color. When satisfied, the fly withdraws its beak and flies rather sluggishly to some near-by object, where it rests while digesting its meal. When the proboscis is withdrawn a drop of blood usually exudes from the wound. Numerous small flies have been seen to frequent the blood which exudes in this way, and it is not improbable that the screwworm fly[4] may deposit its eggs on these spots and thus cause infestation of the host with its maggots.

During warm weather the blood is digested rapidly and the flies may feed again the same day. When the weather is cooler they usually require about a day for the digestion of the blood. After partaking of a meal the flies, during hot weather, ordinarily alight on the walls of buildings or on foliage of plants in shady situations. When the temperature is lower they remain in the sunlight, but in all cases they tend to avoid strong wind.

Adults frequently follow for considerable distances teams traversing roads and finally, when engorged, settle on near-by objects. Other teams which pass along the same highways are thus frequently attacked by flies which have completed the digestion of their previous meal, and this has given rise to the idea that the flies are breeding in weeds, grass, and hedges along the highways. This is also a means by which the flies invade territory beyond that in which they develop. Adults have been observed to travel many miles in the passenger coaches of railways. Few individuals are carried in this way, but doubtless the spread of the species is aided, and, what is more important, diseases might be spread in this way by infected flies.

Feeding may take place a number of times. Experimentally, individual flies have been induced to engorge as many as 14 times. Flies have been observed to partake of water and to feed to some extent on succulent fruit. They feed commonly on the moisture on fresh manure and on rotting straw. Although man is bitten by these flies occasionally, horses and cattle seem to be preferred as hosts. Dogs are also severely attacked, especially on the ears, which are often denuded of hair and made practically raw by the numerous bites.

REPRODUCTION

Mating of the flies takes place while they are not on hosts, and egg laying soon follows, provided the flies have fed a sufficient number of times. It seems that at least three feedings on blood are necessary for the production of eggs. After the third meal is digested the flies seek suitable places for oviposition. When the weather is cool additional feedings are often necessary before eggs are produced. The adults appear to have a keen sense of smell and are able to detect moist straw and suitable manure very quickly. This is especially noticeable when a strawstack which is dry on the outside is opened up so as to expose the moist and rotting interior.

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[4] Known scientifically as *Cochliomyia americana* C. and P.

Very soon after a stack is opened flies are seen coming to the moist straw in numbers and beginning to deposit eggs. Usually they crawl into the loose straw, sometimes going to a depth of several inches. When laying eggs the fly greatly extends the ovipositor and uses it as an organ of touch in locating a suitable spot. The eggs are laid in irregular masses, although occasionally single ones are deposited. The female usually moves several times during oviposition so that each egg mass contains from a few to as many as 25 or more eggs. The greatest number of eggs which a stablefly has been observed to deposit before taking another meal of blood was 122. After all of the eggs have been deposited the female again seeks a host, and this feeding is again followed by egg laying. Three or more of such ovipositions commonly take place in this species. It is sometimes necessary, especially during cool weather, for a fly to become engorged twice before each oviposition following the first. The greatest number of eggs which a single female has been seen to deposit during her life is 632.

LENGTH OF LIFE OF THE ADULT

A knowledge of the length of life of the adult is important in determining its possibilities as a disease carrier and annoyer of animals. Individuals kept in small tubes without food or water during hot weather died within 2 days. When water and sugar sirup were supplied to flies in a screen cage about 1 foot square, one specimen out of a large number of males and females lived for 23 days. Individuals that had access to blood at frequent intervals lived 17 days, and a few specimens, among a considerable number which were kept in large cages with cattle and suitable material in which to deposit eggs lived for 29 days. During cool weather the length of life is still greater. Under more abnormal conditions other investigators have kept individuals alive more than 3 months.

THE LARVA AND ITS HABITS

The larvae, or maggots, begin feeding as soon as they hatch from the eggs and continue to do so throughout their growth. Portions of moist straw or other material in which they are breeding are torn off by their mandibles, which are located on the narrow or head end of the maggot. When very small, they frequently penetrate between the layers of moist stalks or leaves of grain in the strawstack. When larger, they often feed within the straws, and transformation to the resting state sometimes takes place in this protected situation.

The larval period lasts from 11 to 30 days, and during very cold weather probably considerably more than a month. The character and abundance of food and the amount of moisture have an important influence on development, and larvae follow the moisture inward as the material in which they are developing becomes dry on the surface. Pupation occurs anywhere in the breeding material; it frequently happens, however, that the larvae, when in small masses of straw or manure, work downward as the material dries and pupate at the surface of the soil.

LIFE CYCLE

Complete development from the deposition of the egg to the emergence of the adult fly may take place in 19 days, or even in 14 days, according to some investigators. The developmental period, however, usually ranges from 21 to 25 days where conditions are favorable. Forty-three days is the longest period observed, although it is certain that in the late fall and during the winter months a much longer period is often necessary. The finding of full-grown larvae and pupae in straw during the latter part of March 1913, in northern Texas shows that development may require about 3 months, as these stages almost certainly developed from eggs deposited the previous December.

HIBERNATION

In the southern part of the United States there is no true hibernation of this insect. Adults have been found to emerge from their breeding material at various times during the winter when temperatures were not low. It is doubtful whether adults appearing under these conditions ever lay eggs. The individuals which pass the winter successfully hatch from eggs laid in the fall and continue development slowly during the winter, emerging in early spring when the temperatures are favorable for reproduction. In the northern part of the United States few flies emerge during the winter months, this period being passed normally in the larval and pupal stages.

AGRICULTURAL PRACTICES IN RELATION TO FLY ABUNDANCE

Certain agricultural practices favor greatly the development of the stablefly. As has been stated, this species breeds most commonly in straw and horse manure or in a mixture of these two substances. The custom of allowing the manure from the horse stable to accumulate just outside of the stable doors insures the presence of stableflies at all times when climatic conditions are suitable for breeding. Allowing barnyards, especially around dairies, to become knee deep in manure is also calculated to produce flies in abundance.

In the grain belt it is the practice of farmers to thresh the grain in the fields by means of self-stacking threshing machines. The individual stacks cover much ground, and the straw is very loosely piled. In many cases for convenience several stacks are formed in various parts of a field. When threshing is followed by heavy summer and fall rains this loosely piled straw is certain to form a breeding place for great numbers of flies. This is precisely what happened in 1905, 1912, 1926, and 1937, when serious outbreaks of the stablefly occurred. In many instances strawstacks are not protected from livestock. The animals soon scatter the straw and by adding manure still further favor fly breeding. These strawstacks usually are allowed to remain throughout the fall and winter without attention. When the succeeding crop is planted the area occupied by the stacks is simply left uncultivated. In a few cases stacks are burned in the spring, but frequently they are left from year to year, and the new straw is added to the old stacks, destruction only taking place when the stacks become exceedingly large.

It will be seen that these practices not only encourage the breeding of the stablefly, but when the straw becomes sufficiently rotten and compact the housefly as well breeds in it in abundance. Throughout the grain belt a very considerable amount of valuable land is thus left untilled, and the full manurial value of the straw is lost. That the stacks serve some purpose as shelter and feed for livestock kept in the fields during the winter is the only legitimate reason for not scattering them or burning them in the late summer or fall.

NATURAL CONTROL

CLIMATIC EFFECT

The flies feed when the temperature is very high and the sun bright and hot as well as during cool and cloudy weather. They have been observed to attack animals during drizzling rain, and when somewhat protected by sheds and stables they often feed during a heavy rain. The lowest temperature at which flies have been observed to partake of blood was 55° F. When the temperature goes below 60° their desire to feed is less marked. Between 40° and 48° they lose their ability to fly, and complete inactivity occurs when the temperature ranges between 31° and 45°. This range of activity is due to variation in individual flies, to the rapidity of the decline or rise in temperature, and to the minimum temperature experienced by the individuals. No flies appear to be killed by a temperature not lower than 27°, and some at least are able to survive temperatures considerably below this point. All flies at Dallas, Tex., seem to have been killed when the temperature reached 8°. As has been stated, the flies always seek shady places during hot weather, but when the temperatures are lower they delight to dart about in the sun in a manner very similar to that of the housefly.

The maggots, or larvae, are very susceptible to drying. This is particularly true soon after they have hatched. Excessive moisture also is detrimental to their development, and flooding kills them in a few hours. They appear to be able to endure rather high temperatures when abundant moisture is at hand, although the heat produced in manure and strawstacks is often sufficient either to kill them or to drive them outward. No doubt the generation of heat within the breeding places stimulates the development of the immature stages during the fall and winter months. Light is detrimental to the development of the larvae. When placed in bright daylight, even though sheltered from the sun, larvae have never been known to complete development. These facts make it possible to destroy the pest in this stage of its life.

The pupae of the insect, being inactive and protected, are much less susceptible to all climatic extremes. They appear to be able to withstand low temperatures and are not very susceptible to heat or drying, especially after the development of the fly has proceeded for some time.

PREDATORY ENEMIES

Hogs, as well as chickens and other poultry, are capable of destroying great numbers of the immature stages of the stablefly. They are attracted to the strawstacks and manure piles partly by the grain, and incidentally they destroy the maggots and pupae which they find. Several kinds of insects are important destroyers of these stages. Certain beetles devour them in considerable numbers. The adult flies fall prey to numerous enemies. Among the more important enemies of the adults are the large robber flies, which may be seen in great numbers around strawstacks, pouncing upon stableflies which are depositing eggs or resting upon straw. Wasps of several kinds capture the flies that are attacking stock or flying about. When filled with blood, the flies are comparatively sluggish and much more easily caught by these enemies, and spiders often devour them.

PARASITIES

Two species of small wasplike insects have been found to breed within the pupae of the stablefly. These insects deposit their eggs through the hard puparium, and instead of an adult stablefly the little parasite emerges. In some cases, where the immature stages of the fly were concentrated in great numbers, as many as 40 percent of the pupae were found to have been destroyed by these parasites. At least one of the parasites[5] has a wide distribution in this country.

ARTIFICIAL CONTROL

As is the case with most insects, the destruction of the stage which is actually doing the injury is most desired by those concerned. With this species, as with many others, this is very difficult, and some more easy way of securing the desired end must be determined. With the stablefly the natural point of attack is found in the immature stages; and there is every reason to believe that by properly caring for substances in which it breeds, the insect may be kept well under control.

PROTECTION OF LIVESTOCK FROM ATTACK OF THE STABLEFLY

When adult flies are present in great numbers it is necessary to devise some means of protection against them, especially since we know that every individual is capable of feeding a number of times before it dies. Most of the materials used with a view to repelling the flies from livestock have been found to be ineffective and, although some gave a measure of protection for a time, none had a lasting effect. In addition to the temporary value of these substances, in many cases injury was produced by their application, especially if persisted in often enough to keep the flies away. These facts emphasize the importance of taking steps to prevent fly breeding rather than depending on protection of the stock against the flies.

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[5] *Spalangia muscidarum* Richardson.

Work animals may be largely protected from the pest by means of coverings. One type of covering which has been found very effective and inexpensive consists of a blanket made of double thickness of burlap so arranged as completely to cover the back, sides, and neck of the animal (fig. 6). The legs also are then sometimes covered by means of old trousers slipped on over the feet and tied over the back. Leather nets or strips of leather attached to the bridle also aid in keeping the flies from the head. The ordinary fly net has been found to be of little value as it only tends to displace the flies temporarily and cause them to settle in places not covered by the net.

Many malodorous mixtures, particularly of an oily nature, have some value as repellents, but in preparing these care should be taken that they are not made too strong, particularly when animals are being worked in the hot sun, as they are likely to cause overheating and often produce shedding of the hair. A mixture of fish oil (1 gallon), oil of pine tar (2 ounces), oil of pennyroyal (2 ounces), and kerosene (½ pint) was found to be fairly effective in keeping the flies off of livestock for a short time when applied lightly, but thoroughly, to the portions of animals not covered with blankets or nets. Kerosene extract of pyrethrum is a very good spray for killing the flies.

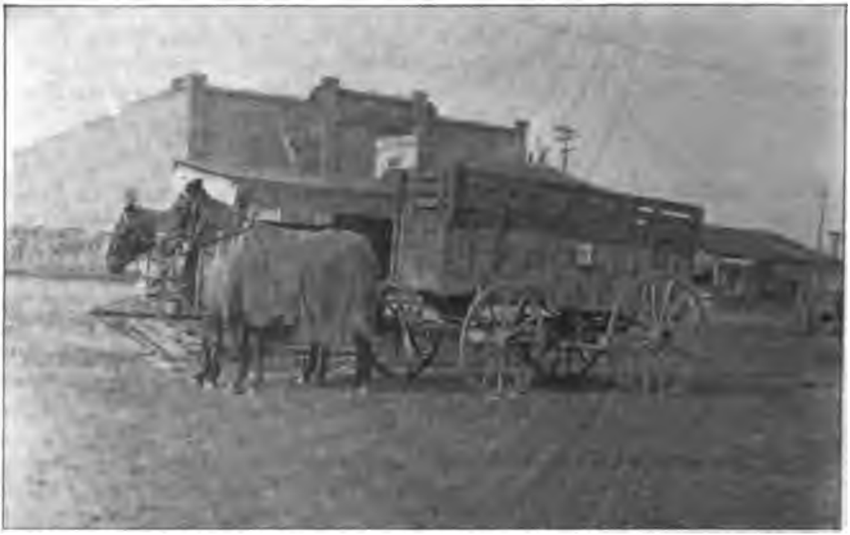

FIGURE 6.—Burlap covering used to protect horses from the stablefly.

Completely darkened stables offer much protection from the flies, although the resulting lack of ventilation is objectionable. The thorough screening of all windows and doors is much more desirable. When screened barns are used, care should be taken to brush the flies from the animals, when they are about to enter, by means of nets over the doorway, or with sacks. The flies that gain entrance to the barn may be killed by spraying with kerosene-pyrethrum extract. After the animals have been driven into the barn, especially if the door is on the south side, numbers of stableflies often collect on the doorjamb and the side of the barn in the bright sunlight. In this situation it is considerably easier to kill them by spraying than when they are on the animals.

Little can be done to protect range stock from the flies. On hog farms a freshly plowed trench offers considerable protection to the swine. The sides of the trench may be smeared with petroleum, which is rubbed off on the animals and acts as a repellent. The trench may be used also for protecting sheep, but the petroleum in their case is unnecessary.

TRAPPING THE FLIES

It is impossible successfully to capture adult flies by means of the traps ordinarily used for the housefly. A trap has been designed by C. F. Hodge, however, which may be utilized in capturing adults as they enter or leave barns. This trap (figs. 7, 8, 9) is undoubtedly very effective under certain conditions and has the advantage of catching not only the stablefly but also the housefly and other obnoxious species. In order to employ the trap for the stablefly, it should be built in a frame so as to fit closely in a window, preferably on the brightest side of the barn and close to the cows or horses kept within. Other windows should be darkened by hanging gunny sacks over them. This may be done so as not to interfere with ventilation, and the sacks, by flapping in the wind and darkening, both drive and cause flies to be attracted to the light-trap window.

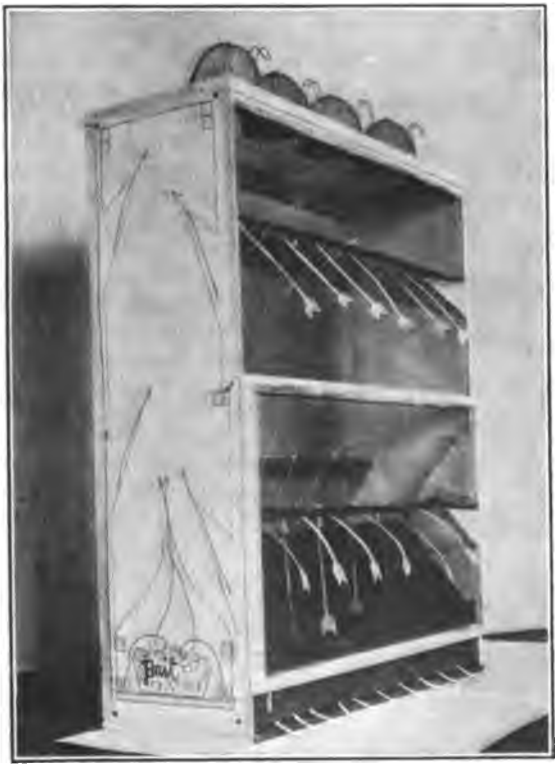

Figure 7.—The Hodge flytrap, showing where the flies enter. (Hodge.)

At the bottom of the trap a space about one-fourth of an inch wide running entirely across the window is left on both sides of the frame. This crack admits the flies beneath a roof or ridge of screen wire having holes large enough for flies to go through punched along its top at 2-inch intervals. To capture the houseflies, bait consisting of any material attractive to them is placed in pans beneath this ridge. The flies enter this space, ascend through the holes, and are unable to escape.

The sides of the trap, also, are made of ordinary screen wire bent inward and upward in two horizontal folds running across the window, one toward the bottom and one toward the top. The ends of the screen are then securely tacked and a series of small holes punched along the inner edge of each of the folds. The flies, in trying to go in and out through the window, crawl into the folds and enter the holes at the apex, but never escape, as on the inside the holes are along the projecting ridge. Professor Hodge states that a trap set in a window in a basement barn near a cow within caught nearly 5 quarts of flies from July 1 to November 1. The stablefly constituted 90 percent of these flies.

This trap is inexpensive and can be made by anyone with a box, or box lumber, and screen wire. It is especially well adapted to well-made barns where the flies do not have numerous places for entrance and exit. It is also more applicable to small barns in which animals are kept more or less constantly than to large dairy barns where the cows are brought in only at milking time. Under the latter conditions the flies enter the barns on the cows and many remain on the walls of the barn until after the cattle have been turned out. In some cases where flies are concentrated in dairy barns in this manner they have been driven out by forcing live steam into the building from the boilers used for sterilizing purposes. Where such arrangements are made the flies may be caught in such traps as the one described, as they are endeavoring to escape from the barn, which should first be tightly closed.

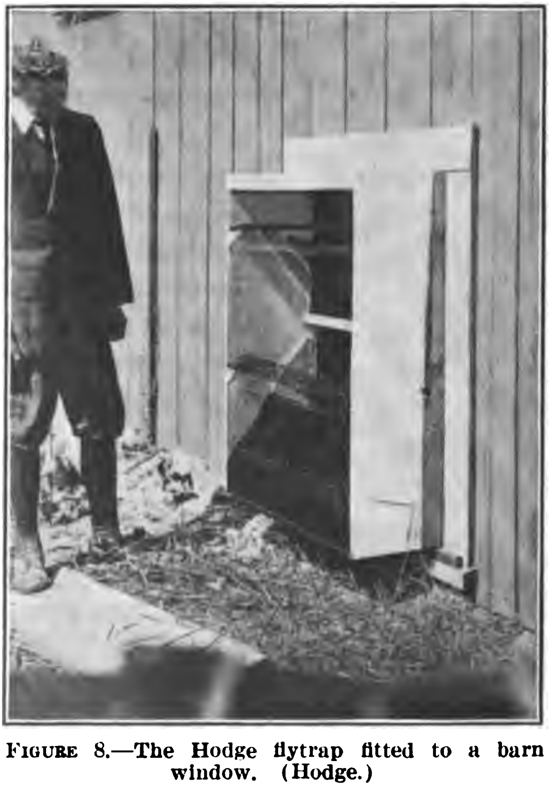

FIGURE 8.—The Hodge flytrap fitted to a barn window. (Hodge.)

If such barns are tightly closed, as above, during the light part of each day and the windows without traps darkened, practically all the flies will "catch themselves" in trying to escape through the trap-window or windows.

Electric grids placed in windows have also been found useful in killing the flies as they attempt to enter or leave the barn.

DESTRUCTION OF IMMATURE STAGES AND PREVENTION OF BREEDING

Since strawstacks have been found to be the principal breeding places of this insect in the grain belt, the proper care of the straw is by far the most important step in control. When the straw is to be kept for protection and food for livestock, it should be stacked with more than ordinary care. The sides of the stack should be made nearly vertical, and it should be rounded up well on top, the better to shed the rain. With blower stackers a very satisfactory stack can be put up by controlling the blower and keeping one or two men on the stack. This method is shown in figure 10. After the stack is complete it is advisable to clean up around its base and to scatter or burn the loose straw and chaff.

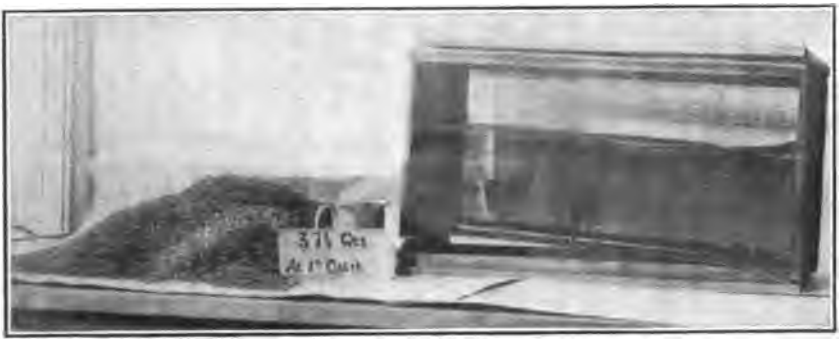

Figure 9.—Pile of flies caught in a Hodge flytrap. (Hodge.)

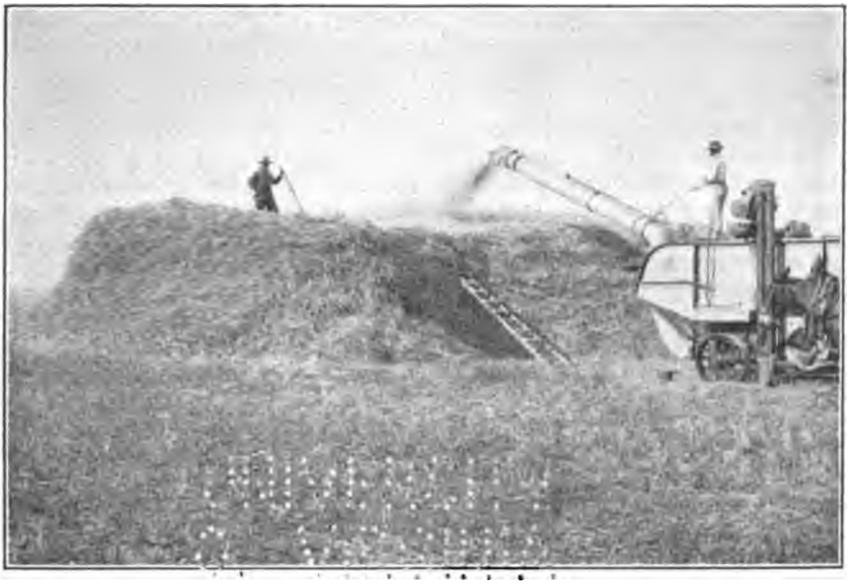

Figure 10.—Stacking straw to prevent stablefly breeding.

So far as possible, all straw that is not required for winter feed for stock should be disposed of immediately by scattering it over the land soon after threshing and subsequently plowing it under, or by burning the stacks. The plowing under of the straw that cannot be used for feed is the most advisable procedure in regions where the moisture is sufficient to cause it to rot rapidly. Oat straw is most generally used for feeding purposes, and this straw forms the principal breeding ground for flies. It is therefore important in regions where rainfall is heavy that all oat straw needed for feed or bedding be baled and stored under cover and that the remainder be promptly burned or scattered. In the drier sections of the country proper stacking of the straw may be depended upon for its preservation.

All strawstacks not consumed by stock during the winter should be promptly disposed of in the early spring, as these stacks furnish flies continuously during spring and summer. Often the flies reared in such situations are abundant enough to cause great annoyance to livestock during the early spring and by multiplying throughout the summer produce an almost incredible number by fall.

The conditions—that is, the heavy rainfall on the freshly threshed straw—which have produced most of the severe outbreaks render the straw largely unfit for feed for livestock, as the stacks in many cases are wet through and soon become heated and rotten. In such instances, where the flies are already breeding in these stacks, their immediate destruction by burning or scattering is necessary to relieve the conditions. When stacks are scattered the work should be done thoroughly, so as to expose the straw completely to the influence of the sun, wind, and light. By this procedure practically all of the larvae and many of the pupae are destroyed. Straw spreaders which are said to give satisfaction are on the market.

It is best to plow under the scattered straw soon after it has become well dried out. In many sections of the grain belt plowing is not generally practiced, the land being simply disked prior to seeding. The scattering of straw over the ground in such cases is less practicable than where the land is plowed; hence wherever plowing can be done, it should be adopted.

In sections of the country where headers instead of binders are used, and consequently a smaller amount of straw is accumulated, the straw is much more easily disposed of by the methods just outlined. The use of combined harvesters and threshers solves the problem of the strawstack, for by this method the straw and chaff are left distributed over the fields.

The use of poisons or other substances, with a view of destroying immature flies in strawstacks, is neither practicable nor advisable. Enormous quantities of these materials would be required to permeate the straw to kill the larvae, and, even though they were destroyed, the straw would be rendered dangerous to livestock.

Although straw is the principal breeding place for stableflies within the grain belt, there is no doubt that thousands of them develop in manure piles. Moreover, such material is utilized extensively as a breeding place for the housefly and horn fly. Hence the proper care of all sorts of animal refuse is essential for successfully combating the pest. Manure should be hauled out and scattered at regular times, preferably every 3 days, as is recommended for the control of the housefly, and any accumulations of straw or hay, especially adjacent to stables, should be disposed of, as these are often utilized by the stablefly for breeding when larger accumulations of horse manure and straw are not available.

Manure boxes provided with a trap on top to catch the flies which breed out (fig. 11) prove very satisfactory for farms with a few head of stock. The box should be as nearly flyproof as possible and the manure put into it at least every 4 days so as to catch the houseflies as well as the stableflies.

Manure pits properly screened and with flytraps provided are adaptable to use on dairy farms, and the maggot trap described in Farmers' Bulletin 1408 will destroy many stablefly maggots as well as those of the housefly.

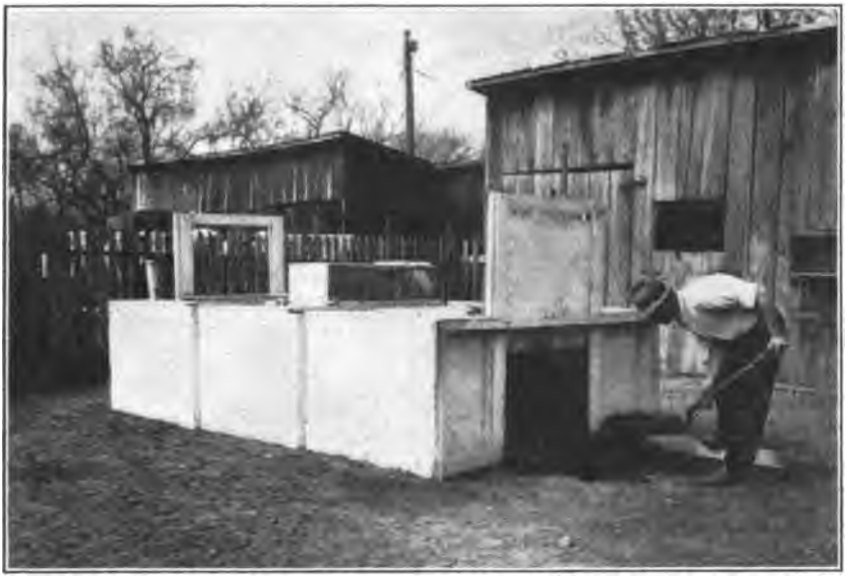

FIGURE 11.—Manure box with flytrap attached.

A large percentage of stablefly larvae as well as larvae of the housefly may be destroyed in manure by treating it with hellebore or borax. The former is used by soaking one-half pound of hellebore in 10 gallons of water for 24 hours and sprinkling this quantity over each 8 bushels of manure. The borax, used in powdered form at the rate of 1 pound to each 16 cubic feet of manure, is scattered over the pile and sprinkled with water. Neither of these substances will injure the fertilizing value of the manure if used in the quantities indicated and if not over 15 tons of the treated manure is applied per acre.

The need of properly caring for stable refuse is still further emphasized by the fact that there are far more manure piles than strawstacks. Furthermore, the stable manure is usually in close proximity to the habitations of man and thus furnishes flies, which have freer access to man, with consequent greater potentiality as disseminators of human diseases.

MEDICATED SALT VALUELESS

Certain medicated salts, most of which contain sulfur and common salt, have been placed on the market. The claim is made that their use in lieu of common salt will protect stock from flies. Such materials are entirely valueless against flies.

U. S. GOVERNMENT PRINTING OFFICE · 1939

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FARMERS' BULLETIN 1098
UNITED STATES DEPARTMENT OF AGRICULTURE

DUSTING MACHINERY for Cotton Boll Weevil Control

THIS bulletin is intended to aid the prospective purchaser of dusting machinery for cotton boll weevil control in selecting a satisfactory model and one adapted to the needs of his particular farming conditions. Different localities frequently require different types of machinery, and the farmer should make sure he is securing one suitable for his needs. In case of questions not covered in this bulletin interested parties are invited to correspond with the Delta Laboratory, United States Bureau of Entomology, Tallulah, La.

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief
Washington, D. C. January, 1920

DUSTING MACHINERY FOR COTTON BOLL WEEVIL CONTROL.

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FOR the past several years the Bureau of Entomology of the United States Department of Agriculture has conducted extensive experiments on the control of the cotton boll weevil by poisoning, and the results have justified the adoption of weevil poisoning on a commercial scale. The experiments have been under the direction of the Delta Laboratory, at Tallulah, La., and have been largely in that neighborhood. In 1918 practical control of some 35,000 acres of cotton was undertaken under the supervision of agents of the Delta Laboratory, and so satisfactory was the outcome that general information on the subject was released and in 1919 poisoning as recommended was attempted by the farmers themselves. On the whole, the results were satisfactory, and it appears that the practice of poisoning cotton for boll-weevil control will spread rapidly.

A determining factor in the results of poisoning is the use of suitable dusting machinery, and so important is this that much attention has been devoted to the development of satisfactory machines of different types. Just now there is great need for placing the accumulated information on the subject in a form available for use. Many manufacturers are planning to build dusting machinery and are absolutely at sea as to the requirements of a satisfactory machine. Furthermore, farmers desire definite information to guide them in purchasing machines that will answer their purpose. The present bulletin, therefore, is intended to serve as a report of progress and to supply as far as possible the two needs just mentioned.

Before taking up the question of machine construction it probably will be well to review briefly the poisoning work from the standpoint of the machinery used. Naturally the poisoning tests as first conducted consisted of small plat experiments where at most only a few acres in one locality were treated. For this purpose, of course, a small-capacity hand-operated dust gun was eminently suitable. Consequently a few changes were made in certain existing guns, which rendered them fairly satisfactory for strictly experimental work and they were utilized throughout the early stages of poisoning. The results of these early plat tests were so favorable, however, that practically the first year's poisoning as arranged in cooperation with certain planters called for the treatment of very large areas. In fact, as mentioned, some 35,000 acres of cotton were treated during that year (1918), and this, of course, necessitated an immediate supply of machinery of the largest capacity possible.

Existing types of power machines were examined and tested, and it was found that nothing suitable for the work was available. Nevertheless, owing to shortage of time, it was necessary to adapt some of these machines to the requirements of cotton dusting and as far as possible to utilize the machinery then existing. Consequently, certain types of orchard dusters were selected, and the necessary changes made to permit their operation in cotton fields. In the effort to utilize these machines, however, many difficulties were encountered which could not have been anticipated, and it became obvious that the operation of poisoning cotton was going to be much more difficult and involved than had been expected. Many factors contributed to cause delays in the operation of the machines, and as practically the entire system of weevil control is based on dusting at exactly the right time, these delays were very detrimental. In fact, it was soon seen that the success or failure of poisoning depended largely on being able to get the cotton treated in the right manner at exactly the right time, and any delay or interruption in this schedule either made the operation much more difficult and expensive or prevented satisfactory results.

In view of the obvious importance of this consideration, the writers undertook an intensive study of the factors affecting the operation of cotton dusting machinery and the actual difficulties experienced. This involved the use of a considerable number of various types of machines throughout the season over large areas. As a result of two years' work of this nature, a rather comprehensive idea has been secured of the conditions which are going to influence the operation of cotton dusting machinery and the difficulties which are most likely to be encountered.

In connection with the entire discussion of cotton dusting, it must be remembered that this operation is now being placed on an extensive basis rather than an intensive one. Generally speaking, in the past the use of all insecticides has been comparatively limited in scope and has practically always been in conjunction with some crop raised under more or less intensive cultural conditions, such as truck crops, orchard crops, tobacco, etc. In all of these crops the areas are comparatively small and the labor utilized has been, generally speaking, of a fairly intelligent type. With the inauguration of cotton dusting, however, the operation is removed entirely from this class and placed on a tremendously extensive basis involving the use of very large areas and a comparative shortage of labor. Consequently, machinery adapted for dusting work such as has been conducted in the past would not serve for cotton dusting and it was absolutely essential to take up the construction of specialized types.

It is of course impossible to make positive predictions as to the future for cotton dusting machinery. Results of large-scale experiments extending over a number of years have been so favorable, however, that the conclusion appears justified that weevil poisoning will prove profitable and thus be adopted in practically all portions of the Cotton Belt. It is, of course, going to involve many failures and partial failures at the outset, but the weevil damage is so great and a method of control so greatly needed that poisoning is bound to prevail on its obvious merits. Just how rapidly it will be taken up is another question, but the importance of developing machinery suitable for this work is well shown by the fact that the weevil has now infested almost the entire cotton area of the United States and there are probably at least 25,000,000 acres of cotton subject to more or less severe weevil damage every year.

For the purpose of this bulletin the different conditions existing which affect cotton-dusting operations, especially as regards the machinery construction, are first presented, then the machinery question itself is taken up and the progress which has been made toward meeting the different problems involved therein are outlined.

FACTORS AFFECTING MACHINE CONSTRUCTION.

CHARACTERISTICS OF AVAILABLE LABOR.

Since in most cases dusting machinery will be operated by plantation negroes, it must be adapted to their capacities. As a rule, these laborers are very limited in their ability to utilize a new implement. They have no mechanical training and as a consequence they are unable to operate a complicated machine requiring elaborate adjustments or repairs. Furthermore, many of them are very careless. About all that can be done, therefore, is to train them in a few rudimentary operations and then attempt to see that they carry them out efficiently. Every step toward simplifying the operation and maintenance of the dusting machine is a tremendous advance toward making it satisfactory and efficient.

Furthermore, the average plantation hand avoids laborious operations, and this fact has special significance when the future use of hand dusters is considered. The most prejudiced advocate of these machines could certainly not call them easy to operate. In fact, nearly all operations with hand dust guns in the past have usually been so arranged that they involved working these machines for only a few hours a day. This will not suffice for cotton, and great difficulty has always been experienced in securing labor to operate these machines continuously.

Another serious drawback to the use of hand dust guns is the reluctance of most plantation negroes to become wet with dew. They have a dread of this amounting almost to a superstition and it is very difficult to persuade them to tramp back and forth through the dew-drenched cotton field. On the other hand, as will be explained on subsequent pages, it is desirable to do as much dusting as possible while the plants are moist with dew.

Generally speaking, the negroes fear the poison. This is probably more or less due to the fact that a great many have had or have heard of injuries experienced while treating cotton with paris green a number of years ago, when this operation was very common for leafworm control. Paris green is decidedly injurious to man when any considerable amount comes in contact with the skin, and while this is not true of calcium arsenate, which is now being recommended for boll-weevil control, it is very difficult to make the laborers distinguish the difference. Consequently, they are very reluctant to utilize any type of machinery which exposes them to a considerable amount of dust, as in the case of hand guns where they are walking through the dust cloud most of the time. Then too, they are likely to attribute any type of illness, real or imaginary, to the poison when there has been any exposure to it. In reality, there is little danger to man from the ordinary use of calcium arsenate as long as reasonable precautions are taken, but extreme exposure to the dust cloud may cause injury in time and is at the least very annoying.

It is desirable, therefore, so to construct the machinery that the operator will be exposed to a minimum amount of dust.

AREA TO BE TREATED.

The area to be treated is an important consideration. As far as the plantation is concerned, this will vary from the small farm with perhaps 5 acres of cotton to the large plantation of thousands of acres. For example, one property, where a great deal of the experimental work of the Department of Agriculture has been conducted so far, plants about 16,000 acres of cotton each year. It is thus necessary to provide machinery suitable for organizations ranging from a very few acres to thousands of acres.

The size of the individual field also varies tremendously, especially in different districts but, generally speaking, throughout most of the territory where weevil damage is severe the cotton crop is divided into fields, or "cuts," ranging from 1 to 15 or 20 acres in extent. These usually are bounded and separated from other cuts by ditches, turn rows, headlands, fences, timber, etc. In certain districts, especially where the rainfall is fairly light, these cuts are frequently very large and the rows comparatively long. On the other hand, in districts of heavier rainfall (and these are the districts where weevil damage is most severe) the necessity for drainage decidedly limits the size of the cut and as a consequence in a great majority of cotton fields rows 1,000 feet long are rare. In addition, a considerable portion of the cotton belt is still only partially cleared and this naturally results in all kinds of irregular and odd-shaped fields. In planning to purchase cotton-dusting machinery the farmer must consider carefully the nature of his fields and the actual ease of operation of different types of machines. Naturally in large open fields with good facilities for turning at row ends and with lengthy rows, large power machinery is desirable, but as the fields become smaller, the rows shorter, and turning more difficult, smaller machines with a more limited capacity are necessary.

NATURE OF FIELD.

Another important consideration is the presence of stumps or other obstructions in the fields. Generally speaking, "new ground," where stumps are prevalent, is a fertile soil and thus adapted to producing the highest yield of cotton; on the other hand, this nearly always adjoins timber or other weevil hibernation quarters and thus receives the heaviest infestation in the spring and requires the greatest amount of treatment for weevil control. It is not customary in the cotton belt to remove stumps from land on clearing but the practice is to allow them to rot out, and it thus becomes necessary to dust a large number of fields of cotton of high potential productivity with a heavy weevil infestation and so full of stumps that it is almost impossible to drive a team through them. Figure 1 shows a field of this type which was poisoned at Scott, Miss., during 1918 and 1919. Driving through such a field during the day would be difficult enough, but at night when the stumps are more or less hidden by the plants and many are absolutely invisible, even with the best of lights, it becomes a serious problem. It is impossible to keep from running upon a stump occasionally and where wide distributing systems are utilized extending several rows beyond the side of the machine, it is impossible to avoid occasional collisions.

NIGHT OPERATION NECESSARY.

The importance of night operation has already been mentioned several times, but it is probably well to outline briefly the necessity for this. The basic principle of the present system of cotton dusting requires that every portion of the cotton plant be thoroughly covered by the fine particles of poison. This means that a dust cloud must be created which will drift throughout the cotton. Of course it is desirable to have as much of this adhere to the cotton plant as possible, and thus the presence of dew greatly increases the efficacy of the application. In addition to this, however, atmospheric conditions must be just right or the poison has a tendency to drift off and not settle down through the plants. This is, of course, largely a question of humidity, air movement, etc., and by far the best conditions for dusting are experienced at night when the air is calm and the humidity high and when the dust cloud will drift through and permeate to every portion of the cotton plant. Occasionally days suitable for dusting are experienced, such as calm, cloudy, misty days, but these are rare and usually there is sufficient wind throughout the day to cause the poison to drift away above the tops of the cotton plants and thus fail to cover them thoroughly. For this reason, with the machinery now available, all efforts have been aimed toward doing as much dusting as possible during the night and operating during the day only when necessary. On the other hand, as will be shown later in this bulletin, the machines now available are limited in their blowing capacity, and it seems quite possible that with an increased air blast, such as will undoubtedly be introduced on some machines in the future, it may be possible to get the dust distributed throughout the plants even under ordinary daytime conditions and thus render night operation unnecessary. Until such machinery is built, however, plans should be made for night operations.

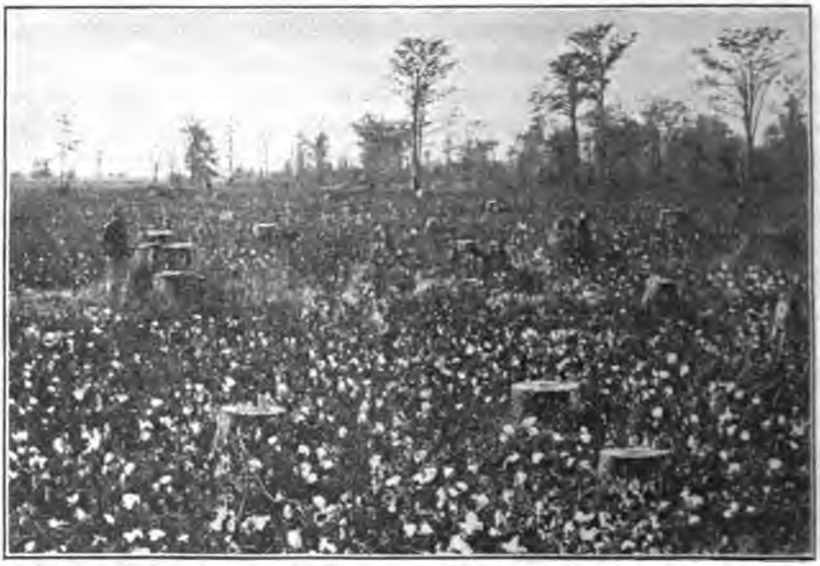

FIG. 1.—Mississippi cotton field showing stumps among which dusting machine must operate.

In addition to the troubles already pointed out as incidental to night dusting, there are many other difficulties. At night the labor is even more careless and inattentive than during the day and is supervised with much more difficulty. A small breakdown which could be easily repaired in daytime and would occasion very little trouble becomes very difficult at night and will often cause serious delay. Machine repair work by the light of a lantern is not a thing of joy, and is fraught with difficulties which must be experienced to be appreciated. Furthermore, driving is much more difficult at night. During the day it is easy to see and gauge the depth of the ditches, but these are often hidden by weeds at night and consequently the machines are subjected to very severe jolts and strains. In fact, one of the greatest difficulties which has been experienced so far in the construction of dusting machines has been building them strong enough to withstand their rough treatment, and this is undoubtedly due as much to night operation as to any other factor.

Another feature of night operation is the presence of dew on the plants and the fact that all portions of the machine coming in contact with these plants become so heavily laden with dew that special devices must be arranged to prevent this from interfering with machine operation. These will be discussed in detail later in the present bulletin.

CHARACTERISTICS OF THE POISON USED.

For the purpose of cotton dusting, the Department of Agriculture is now recommending calcium arsenate, and as this compound varies widely in its physical properties, the different types have been tested and the one form most suitable for the work has been selected and particularly recommended. This material is much lighter than the ordinary insecticides; in fact, the standard specifications call for a volume of 80 to 100 cubic inches to the pound. The characteristics of this material must be considered very carefully in planning dusting machinery. Probably the most important point in this connection is its stickiness and tendency to pack on the slightest occasion. This is especially pronounced during night operations when the humidity is high, and it has caused the elimination of many otherwise satisfactory features on dusters. It simply means that at no stage of the handling of the calcium arsenate from the time it starts through the hopper until it is blown out of the nozzles must there be any opportunity for it to pack or clog the machinery. Agitators must be provided in the hopper, therefore, for passing the material down to whatever feeding device is used. Furthermore, the feeder must be of such a nature that the material will not clog in it. Then, too, all delivery ducts, pipes, nozzles, etc., must be so arranged that there will be an absolutely free flow of the dust-laden air and no eddies or obstructions which will cause clogging. In the case of hand guns, this frequently necessitates the use of some kind of agitator or vibrating arrangement to keep the dust in circulation; and in certain types difficulty has been experienced with feeding, due to the fact that where brush feeds are utilized, these will often dig out a sort of cavern for themselves in the mass of dust and then stop feeding.

As has been mentioned, a successful dusting consists in thoroughly covering all parts of the plants with the exceedingly fine particles of calcium arsenate. This, of course, means that the better the powder is broken up into its finest particles the more efficient the dusting and the smaller the amount required per acre. With the dusting machinery available when first tests of power dusters were conducted several years ago, it proved impossible to treat cotton satisfactorily with less than from 15 to 20 pounds of poison per acre. By improving the machinery, however, so that the dust is broken up better and thus distributed over a larger area, it has been possible to reduce this dosage to about 5 pounds per acre and secure the same satisfactory results, and still further improvement along this line appears possible. In fact, if it is possible to break up the powder into the finest particles and to distribute these evenly through the plants, there is sufficient volume in 2 pounds of poison to treat an acre of cotton satisfactorily. All efforts, therefore, should be bent toward improving this feature and thus reducing the poundage required. It is true that weevil poisoning is profitable at the present dosage, but when the extensive areas to be covered are considered the saving involved in a reduction of even 1 pound per acre in the dosage required will be enormous each year and well worthy of a most earnest effort.

TYPE OF DUST CLOUD REQUIRED.

The type of dust cloud necessary for successful cotton dusting also bears directly on machine construction, particularly in relation to the arrangement of the nozzles or distributors. At the outset it was considered advisable to use some adjustable type of nozzles so that they could be placed directly over the rows regardless of the row width. This was soon found to be impracticable, however, owing to the extreme variation of row widths within a field or even from end to end in the same row. Furthermore, it was found that it was not necessary to blow the material directly on the cotton, but that the powder which simply drifted on the plants would be just as efficient for the purpose of weevil control. Consequently all distributing systems are now arranged with fixed nozzles at approximately average row widths or a little wider, but with some system of deflectors which produces a solid cloud of dust extending through all the rows and filling the plants so completely that it does not matter whether the nozzles are over the rows or between them. Nearly always it has proved possible to poison a few extra rows beyond the actual extension of the distributing system by creating a sufficient dust cloud to allow it to drift. On favorable nights when the plants are thoroughly moist and when there is no breeze to blow the dust away, as many as 15 to 25 rows have been poisoned in this manner from a distributing system extending over only 5 rows. Figure 2 illustrates very well the type of dust cloud desired for a successful poisoning and shows how the dust penetrates between all parts of the cotton plant and thus renders unnecessary any efforts to place the nozzle directly over the row.

MANNER OF PACKING THE POISON.

Even the manner of packing the poison has a direct bearing on the machine questions involved. Unfortunately, a large portion of the poison purchased during 1918 was packed in light-weight barrels with paper liners. These paper bags were supposedly so arranged that when the head of the barrel was knocked in, the top of the bag would be untied and spread back over the barrel so that the poison would be dipped out without disturbing the paper. In reality, however, this practice was never followed, and it proved impossible to get the laborers to do it. The usual system was to knock in the head of the barrel hurriedly and then tear the top of the bag open. As the poison was lowered in the barrel the paper interfered with dipping and sections were constantly being torn from it. This resulted in the introduction of small bits of paper into the machine hopper with the dust, where it wound around the agitator and at last practically shut off the feed. The operators devote little or no attention to the actual amount of dust being discharged, simply noting that the regulator is set at the point at which they have been trained to open it and watch-

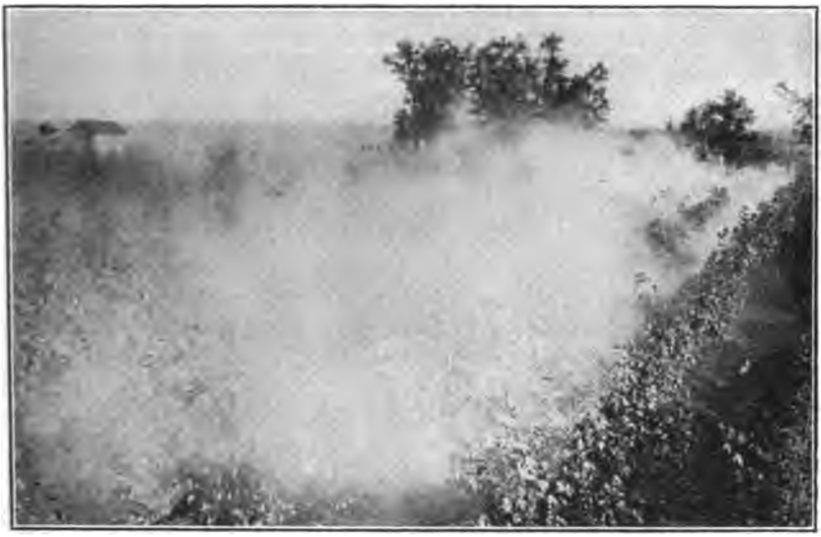

FIG. 2.—Type of dust cloud desired for successful treatment of cotton plants.

ing the hopper to see that it is always at least partially filled. Consequently, they would run along happily with the regulator open, the hopper full, and practically no dust coming out of the nozzles. This, of course, resulted in many spots of unpoisoned or partly poisoned cotton before the difficulty was discovered and corrected, and these spots served as points of weevil infestation for the remainder of the field. Even after the trouble was noted it was necessary to stop the machine for from 10 minutes to a half hour and clean out all the obstructions, causing a considerable loss of time.

In addition to this paper, small scraps of wood from the barrel heads were constantly getting into the machines, and in 1919 it was deemed desirable to try to sift the poison in feeding it into the hopper. For this purpose, the funnels utilized in hopper filling were built with a rather large mesh wire screening across the mouth; this expedient delayed the filling operation somewhat and proved useless, for the operators very carefully knocked the screen out of all the funnels.

For these reasons it is strongly recommended that all poison used be purchased in tight, unlined containers, thus obviating at least a portion of the difficulty.

From the foregoing paragraphs it is seen that to be a success the cotton-dusting machine must be as nearly fool-proof as possible. It must require a minimum of attention, adjustment, and repair, and must be simple to operate. Furthermore, it must be built to stand very rough treatment and all kinds of sudden jars and shocks.

MACHINE CONSTRUCTION.

HAND GUNS.

Many types of hand guns have been tested but so far the only ones found satisfactory for cotton dusting have been more or less similar in general plan of construction. Figure 3 shows two of these guns in operation and gives a general idea of their form. The guns are all of light-weight, sheet-metal material, and usually consist of a fan housing and dust hopper, either united or separate, with some simple crank and gear arrangement for securing a reasonable fan speed. Several feeding devices are utilized, some of which introduce the dust into the air duct beyond the fan while others introduce the dust directly into the fan, which discharges it into the air duct. This air duct then leads through a short tube to some type of spreader nozzle for delivery on the plants. All of these machines are provided with some simple strap device for suspending them from the shoulder of the operator.

OPERATING AREA.

In figuring on the use of the hand gun, it is, of course, necessary to take the speed of operation into consideration. A considerable number of observations based on small areas have shown an average speed of operation of about 1 acre per hour per gun. It has been found, however, that this speed can not be maintained in continuous operation. In fact, the operation of dusting with a hand gun has proved so laborious that in most of the work conducted so far, dusting has been confined to a few hours in the early morning and late evening. In this way it is possible for a man to operate a gun for from three to four hours in the morning from daybreak onward and for about the same period just before dark in the evening. Even by arranging a schedule in this manner, however, it has been found that the maximum area that a laborer can be expected to dust in a day is about 5 acres, and in reality as much as this is seldom covered. So far little attempt has been made to utilize hand guns at night, but this is quite as feasible as operating them during the day, especially if the operators are equipped with some simple type of headlight, such as the ordinary carbide or kerosene lights made for attachment to the hat. In the tall cotton where it is difficult to direct the dust on the top of the plants when walking on the ground, and in fact even in the smaller cotton, it has frequently proved much more satisfactory to operate hand guns from the back of a mule. The animal quickly becomes accustomed to the noise of the gun and much more speed can be made with much less labor by riding a mule down the row and cranking the gun from the saddle.

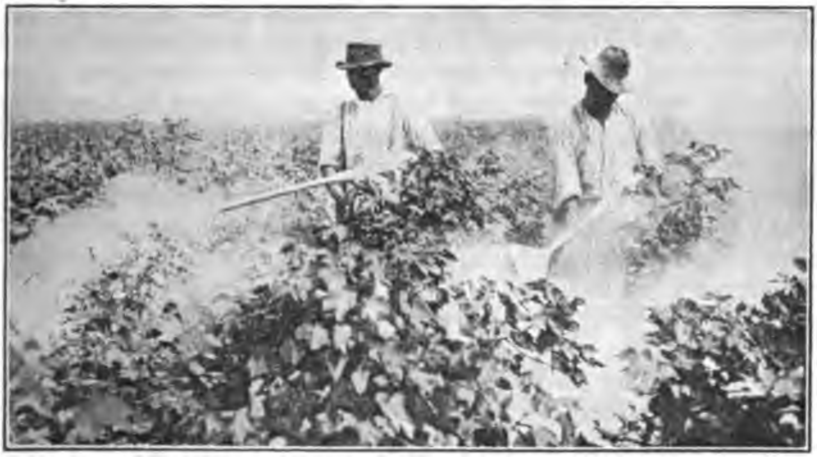

FIG. 3.—Hand guns in operation in a cotton field.

LIMITATIONS AND PRINCIPAL USES OF HAND GUNS.

Considering the matter as a whole, the hand guns utilized so far can hardly be classed as more than a temporary expedient pending the development of something more satisfactory. In order to conserve weight a great deal of attention is always devoted to lightness of construction, and as a result it has been very difficult to secure a hand gun which would stand up under the service required of it in cotton dusting. The rough usage has usually proved too much for the machines, and as a rule it has been necessary to figure on a supply nearly double the actual requirement in order to have enough to replace breakage. Furthermore, from the standpoint of the labor supply the hand guns apparently are seldom practicable on areas exceeding a very few acres. In every case known to the writers in which poisoning with hand guns has been attempted on areas amounting to 100 acres or more, the labor difficulties were such that very unsatisfactory results were secured, and it seems generally inadvisable to attempt to utilize hand guns on such areas.

Probably one of the most important uses of the hand gun consists in its operation in conjunction with larger power machinery. In nearly all places there are a certain number of cuts or portions of cuts where, on account of stumps or some other features of this nature, power machines can not well be operated. In such cases the efficiency of the power machinery is greatly increased by the possession of a few hand guns for occasional use in caring for these unhandy places. thus permitting more rapid operation of the power machines. Quite frequently the large-scale work has been so arranged that approximately 10 hand guns were used with profit in conjunction with each power machine. Furthermore, they are of additional value early in the season when the weevils are frequently confined to comparatively small spots of the larger cotton in the fields, and it is possible to go in with hand guns and dust only a few acres and thus at least delay the general infestation of the fields.

CAPACITY OF THE HOPPER.

One of the most important features of hand-gun construction is the capacity of the hopper. Owing to the lost time involved in filling when it is necessary to walk some distance to the supply barrel, it is desirable to arrange the machine to carry as much poison as practicable. On the other hand, this quantity is limited by the weight of the machine. Most of the machines manufactured so far weigh from 10 to 12 pounds empty and will contain from 5 to 7 pounds of dust. This means that the hopper must have a capacity of from 500 to 700 cubic inches. . In this connection it should be noted, of course, that the hopper capacity should in reality mean the amount of poison which actually can be discharged at a single filling. With certain types of feeding devices it has been found that there is so much back draft from the air duct when the hopper is only partially filled that, although the hopper may hold 4 or 5 pounds of material, only 1 or 2 pounds could be discharged before the back pressure interfered so seriously with the feeding that it was necessary to refill the machine. In such cases, of course, the poundage which must be carried but can not be discharged is simply a dead weight and so much loss in machine efficiency. In the selection of a hand duster, therefore, it should be determined how nearly empty the machine can be operated and a satisfactory discharge of poison still secured.

WEIGHT AND BALANCE OF GUN.

It is difficult to set a definite limit on the weight of the machine, as this depends largely upon its balance. A well balanced machine with the center of gravity very close to the operator naturally causes much less strain upon him than a poorly balanced machine of the same weight with the center of gravity farther forward. A maximum weight of from 18 to 20 pounds for a well balanced gun with full hopper probably is not too much, but to make a machine any heavier than this would be inadvisable unless the operation of the machine was much easier than is the case with any existing models. The strain of operating a hand gun lies not so much in the labor of turning the crank as in the task of combining the operations of walking, cranking, and directing the machine. One of the most important points is to have the dust chamber, which is naturally the heaviest part of the machine, as much to the rear as possible, thus reducing the leverage on the operator.

The machines now utilized may be divided into two classes, according to the manner in which they are carried, namely, those which rest against the side of the operator and those which are held against his abdomen. Each class appears to have its advantages and disadvantages but from observations of laborers while employed in this work it appears that a gun which rests against the abdomen seems preferable, especially if it is furnished with a broad contact surface.

ELEVATION OF DUST DELIVERY.

The height at which the dust cloud must be delivered must be taken into consideration in planning a machine. Of course, the plant height of cotton varies widely in different districts and during different seasons, but as a rule it is necessary to direct the dust cloud from a hand gun at a rather high elevation because most of the cotton is dusted comparatively late in the season when the plants usually have reached a height of from 3 to 4 feet or more. In most hand-gun work it is necessary to have the nozzle at least horizontal with the gun or in some cases even higher than the main body of the gun. Furthermore, it is necessary to send the dust rather directly into the plants, and this is only feasible with a fairly short pipe uniting the gun and the nozzle. Generally speaking, it has been found best to utilize a delivery pipe from 3 to 4 feet in length—certainly no longer than this. In addition, the take-off from the gun proper should be so arranged that when the gun is held in a normal position the delivery pipe will extend forward horizontally and not be directed downward, as is usually the case.

INEFFICIENCY OF TWO-ROW HAND GUNS.

In several instances the attempt has been made to use hand guns for two rows at a time instead of one. This has been accomplished by putting a Y branch on the outlet pipe and thus leading to two nozzles supposedly separated about the width of an average row.

This is not advisable, as thus far no hand gun has been developed which has more power than is necessary for dusting the single row efficiently.

NOZZLES.

As to the nozzles, there are a number of types of these and they usually consist merely of some form of spreader device which flattens the dust cloud as delivered from the outlet pipe, thus making it cover a greater area. Several forms of nozzles seem equally satisfactory, and in selecting the nozzle it is necessary only to note that it is arranged so that it spreads the dust cloud instead of breaking the force of it. In some devices the air current is directed against some form of deflector which tends to reduce the air current so that the efficiency of the dusting is reduced. The nozzle openings must have a fair width in their narrowest dimension, for they are frequently trailing in wet cotton plants and if too narrow and confined this moisture will soon cause them to clog. Furthermore, even the best of nozzles will clog occasionally and should be readily accessible for cleaning.

DUST-FEEDING DEVICES.

A number of feeding devices have been utilized and several have proved satisfactory. The primary requirement is a quick, simple, and positive adjustment which will give a delivery range of from practically nothing to a maximum of about 20 to 25 pounds to the acre. In other words, the maximum delivery of the feeder when wide open should be about four-tenths of a pound per minute. The feed should also be of such a type that no dust is delivered into the air duct when the fan stops. Special difficulty has been experienced with certain types of guns with open slits or holes for gravity feeding which allow the dust to fall through into the air duct when the fan is stopped; when guns of these types are started again the pipe clogs and either blows the powder out in lumps or actually stops up and makes it necessary to take the machine apart in order to clear it. While cotton plants are planted continuously in the row, there are always numerous skips in the stand where it is desirable to stop the machine for a few steps, and the same is true at row ends. Consequently, a machine can not be satisfactory for cotton dusting which has this tendency to clog.

GENERAL CONSTRUCTION.

In the machines utilized so far the general housing construction has been of two types. In one case the fan and hopper have been housed separately, while in the other the two are included in the same general housing. Apparently the latter form is preferable, as it adds greatly to the general rigidity of the machine and seems to be much less subject to breakage in handling, due to more compact construction. This also affords an opportunity for shortening the weighty portion of the machine and thus holding the center of gravity closer to the body of the operator.

All guns which have proved satisfactory so far have been of a rotary fan type, giving a continuous blast of air. A few models have been tested which were equipped with a bellows arrangement and leverage device giving an intermittent current of air, but these have proved totally undesirable for this work because a continuous flow of dust is absolutely essential. Furthermore, these machines have so far failed to give the volume of air current desired.

In future construction every feature of the hand gun must be considered from the standpoint of making it as strong as possible. It is needless to go over many points in detail, but it should be remembered that every joint in the machine should be made in the most rigid manner. Of course, most of this work is done by crimping and soldering, and experience has shown that much improvement can be made and increased service rendered by the guns if this work is done more carefully than is usually the case. For example, one trouble experienced with the machines as they were originally constructed was the longitudinal splitting of the delivery pipes at the joint. It was found, however, that with better workmanship this trouble could be practically eliminated. In the same way good workmanship and good material are essential throughout the guns. All of them depend upon some arrangement of gears for securing their fan speed, and much trouble has been experienced in the past owing to poor alignment of these gears. The question of bearings is quite an important one also. Many dust guns have been built with only the crudest form of bearings, such as holes drilled through the iron framework. This not only greatly increases the friction and therefore the difficulty of turning the machine, but also causes rapid wearing of the parts and quickly results in bearing or gear trouble. In reality, any piece of machinery operating at the speed at which these fans are supposed to turn should certainly be equipped with either ball or roller bearings. Owing to the continued presence of calcium dust in the air it is desirable to have these bearings as well protected as possible, as this dust has a tendency to mix with the oil and form a gummy substance which greatly retards their operation.

Whenever possible, it is desirable to arrange some sort of housing for the protection of the outside gearing on the machine. The gun is in contact with the cotton plant so much that the leaves are constantly working into the gears, if exposed, and filling up the teeth so that these are choked and thrown out of alignment and the difficulty of operation is greatly increased.

Another comparatively minor difficulty which has, however, caused much trouble in the past has been the method of fastening the straps utilized for supporting the guns. These are made of cloth webbing and as a matter of convenience in manufacturing, the different sections are usually riveted to the hooks fastening them to the machine. Many forms of rivets have been tested but thus far one has not been found which will not pull out of the webbing after very little use. Consequently, it is desirable to have these sewed instead of riveted, and if any rivets are used they should be of rust-proof material. In this connection the ordinary type of eye soldered to the machine, to which these straps are fastened, has always proved too weak and has pulled off very quickly. It is advisable, therefore, to have these eyes riveted as well as soldered to the gun housing.

As a rule the opening for filling the hopper is so small that it is necessary to use some type of funnel and this is subject to considerable clogging. The opening for filling the hopper, therefore, should be made as large as possible.

Another point which must be determined entirely by the type of construction in each particular gun but one which it is well to bear in mind is the desirability of having as many parts as possible accessible for quick and convenient repair. Every additional part which can be reached conveniently for repair or replacement adds that much to the value of the machine.

The best machine is one which will give the maximum service with the minimum attention under very rough handling and which will cause the least possible strain on the operator. It seems so difficult, however, to attain this happy combination that from present prospects the future use of hand guns in cotton-dusting work seems comparatively limited, especially when other types of machines of larger capacity shall have been developed. In this connection, one of the most promising types now under consideration is what might be called a saddle model. Such a gun is now being evolved experimentally at the Delta Laboratory. The idea is to build a gun which will rest solidly on a saddle and so arranged that the rider can crank the machine while sitting in the saddle. Thus it will be possible to increase considerably the hopper capacity as well as the fan power, and it seems feasible to arrange some scheme by which the dust can be directed backward through two pipes leading out on each side of the mule to the nozzles, so that two rows can be covered at a trip. Furthermore, it should be possible to equip a machine of this type with some double-crank arrangement by which the operator could run the machine with either one or both hands and considerably reduce the labor of operation.

POWER MACHINES.

As has been mentioned, it was necessary to secure machines of a larger capacity for handling the work when the dusting was begun on an extensive scale. The only machines at that time which appeared to meet the needs were orchard dusters which for their original use could be mounted on almost any kind of wagon or truck. To adapt an orchard dusting machine to cotton dusting conditions it was necessary to mount it on a specially built truck and equip it with a distributing system which would carry the dust to a number of rows at a time. Although these machines with everything working properly were capable of covering a large acreage in a day, many difficulties were experienced when they were placed in practical use. The trucks as built at first were too light and much breakage was the result. In one instance, in which seven machines were used on one plantation, it was a daily occurrence to carry one or more of the machines to the blacksmith shop to have the axles welded.

The distributing systems, which in most cases carried five nozzles, gave continuous trouble from the dust sticking and clogging the pipes, thus causing serious loss of time in clearing them. The nozzles of this system were spaced 4½ feet apart. Thus in the five-row machines the distance from center to center of the outside nozzles was 18 feet, and considerable bracing was necessary on the back end of the machine to support the piping. In moving about from field to field it is usually necessary to remove the end sections of the pipe in order to get through gates, etc. The average width of a gate in the cotton belt is about 10 feet, so that even with the end sections of the pipe removed, very careful driving was required in passing through them and it was not an uncommon occurrence for the distributing system to be caught against trees or fence posts and for the machine to be damaged to a serious extent. Considerable time was required in taking down and reassembling these distributing systems for moving and often the reassembling was done rather loosely, resulting in either lost or broken parts. Figure 4 gives a good idea of the general appearance of one of these power dusters in operation.

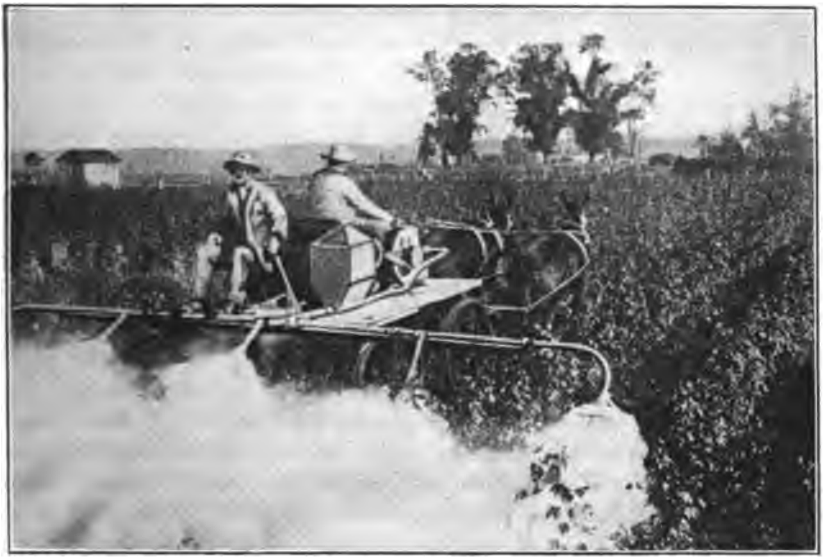

FIG. 4.—Power machine in operation in a cotton field.

TRUCK.

The trucks of these machines had a wheel base of 72 inches and a tread of 52 inches; the wheel base being made as short as possible to accommodate the platform, and the tread such as would clear the cotton rows in the district where used. The tread on the machines used to date has been the same for all regions. As will be discussed later, however, it will be necessary to change this.

It was a frequent occurrence on the first machines for the wheels to become warped or bent out of shape and for the tire to be flattened where it would strike stumps, drop into ditches, etc., but this has been overcome by making the hub larger to accommodate more and heavier spokes and using thicker material in the tire. Also the center of the tire had a channel or groove pressed in it to make it rigid. The front wheels were made smaller in diameter than the rear in order to allow them to turn back under the platform and permit short turning of the machine. The axles were bent or arched to give a clearance of 42 inches from the ground and it was at the bends in these axles that the great amount of breakage occurred. In the beginning, these axles were made of 1½ inches square material and the bends made with a sharp corner on the inside or almost at a right angle; also, the thickness had been materially reduced in the bending process. On the trucks built for the 1919 season's work, the size of the axles was increased to 1¾ inches square, and all bends curved gradually instead of turning with a sharp corner on the inside. This construction proved amply strong to meet the conditions and no further trouble from this source was experienced.

On the earlier machines, although constructed for the front wheels to cut under for short turning, the clearance was not sufficient and if the truck was not standing level the frame would be slightly twisted and the top of the wheel would catch. The fifth wheel construction, held together by a kingbolt, caused considerable trouble from the fact that the parts were not rigidly fastened together, and that the kingbolt was drawn up so tight that it would not give sufficient freedom to the front wheel, when running over obstructions, to prevent twisting the entire frame of the machine. It was not uncommon for the nut on the kingbolt to be lost and for the front wheels to be pulled from under the platform in crossing ditches. Some of the trucks recently constructed have a fifth wheel with a hinge arrangement which will permit one of the front wheels to be raised a distance of about 16 inches without throwing any strain on the framework. This is a decided advantage in crossing ditches or on rough land.

So far the system for hitching the horses to the machine has been unsatisfactory in that the only provision made for carrying the singletrees has been from rigid framing running direct from the axle of the machine. This sort of a hitch throws all the load on one horse if the other is inclined to loaf and has proved so objectionable that users have in many cases rigged the machine with a set of doubletrees. This, however, has not been thoroughly satisfactory since, owing to the high arched construction and elevation of the tongue, it brings the line of draft entirely too high on the team, but even with this objection it is preferable to the rigid hitch.

The platforms of the machine are 8½ feet long by 4½ feet wide, built of 2-inch tongued-and-grooved material with the boards running the short way and the edges bound with angle irons extending the entire length of the platform to prevent excessive warping and in addition strengthening the whole construction. Experience has proved that it was necessary to make these platforms of this heavy material, since oftentimes several barrels of dust are hauled to the field on a machine, and wood of any less thickness is not satisfactory to stand the strains of the load and does not hold the bolts satisfactorily for fastening the machinery and running gear to the platform. The platforms are supported by two channel irons running their entire length and resting on the rear axle and fifth wheel. Some machines have a heavy channel iron securely riveted to the frame channels extending across the back end the full width of the platform and forming a rigid support for the distributing system, while in others the distributing system is bolted to the back of the platform itself. This latter type is found very unsatisfactory in that the bolts will pull out owing to the great vibration or, when obstructions are struck with the piping, the planks will split off. This trouble is eliminated when the distributing system is bolted to the cross-channel as mentioned above.

ENGINE.

It can not be said that the engines used were unsatisfactory from the standpoint of engine construction. When a size large enough to furnish the power required was selected, very little trouble was experienced if they were given intelligent attention, but operated as they were by a class of labor which knew nothing about them they did cause considerable delay in the work, not so much by breakage as by being out of adjustment or in many cases only out of fuel or oil.

The engines used for the various power dusters varied from 2 to 3½ horsepower. A few machines were equipped with 1½-horsepower engines, but these proved too small for the work. Water-cooled engines have generally been used; consequently, it has been found necessary to put a cover or baffle over the top of the water hopper to prevent excessive splashing which would waste the water and sometimes scald the operator. Since the engine was naturally subjected to a great deal of dust, trouble was experienced by parts becoming gummed with a mixture of oil and dust. While no serious difficulty was experienced from the dust being drawn into the cylinders, still a great deal was carried in with the air, making necessary more frequent removal of carbon. The vibration of the engine has been decidedly objectionable; in fact, it tends to loosen parts on the whole machine and cause excessive packing of the poison dust in the hopper and in some cases introduces difficulties in the lighting system.

Much difficulty has been experienced with the belting on the power dusters. During the dusting season the machines are out in the weather most of the time, where they are subjected to extremes of moisture and heat, which make it hard for any belting to stand up under the service. So far, rubber or gum filled fabric belts have proved the most satisfactory, but, owing to the short distance between the pulleys over which some of the belts run, considerable slipping has occurred, and to overcome this the use of various belt dressings has been resorted to—usually some sticky material which causes dirt to collect on both belting and pulleys and to pull the rubber from the inside of the belt. Another source of trouble has been the use of belt tighteners, which were often adjusted to make the belt excessively tight, thus causing unnecessary friction on the bearings and wearing them rapidly. It is a common occurrence for the operator in adjusting the belt tightener to pull it as tight as possible and then not touch it again until the belt has become so slack that it slips on the pulley.

DUSTER.

The duster machinery proper, consisting of a fan, a dust container, or hopper, and the feeding mechanism, has been the source of considerable trouble, and careful consideration should be given to its selection and design. The fans used on the machines have varied in diameter from 9 to 15 inches, running at speeds of from 2,000 to 4,000 revolutions per minute. None of these fans has been capable of delivering as high a pressure as is desired. On some types of machines the fan has not been properly attached to the shaft to prevent it from working loose, which would at least reduce the blast and sometimes stop it completely. When only loose and still delivering a light blast, the difficulty is hard for the average operator to discover. Then, too, these fans were not constructed to prevent end thrust of the shaft from causing wear on the inside ends of the bearings and ends of the fan hub, which eventually allow the blades to come into contact with the housing, thus wearing down the edges of the blades and in some cases catching and breaking them.

Various schemes for feeding devices have been used. Some have rotating brushes which force the dust through perforated plates, the quantity of dust going through being regulated by opening or closing the perforations. Others merely permit the dust to feed by gravity through comparatively large openings. The latter method was used on the first machines but was not entirely satisfactory in that it was not positive and thus did not give the desired even flow of dust. To overcome this difficulty, a feeding device was designed and was patented under Government Patent No. 1282697. This device is an auger which can be raised or lowered and permits positive regulation of the feed from complete cut-off to the maximum quantity needed. Owing to the tendency of the dust to pack it is advisable to use some system of agitators in the hopper which will keep the dust loose and free to flow to the feeder.

The dust container or hopper should have a capacity of at least 3,000 cubic inches, or enough to hold 30 or more pounds of dust. It should be so shaped that all of its contents can flow by gravity to the feeding mechanism. The opening for refilling should be as large as construction will permit, as it will allow the filling to be done with greater rapidity and less waste of material than where the opening is small. Also it makes the interior much more accessible for making repairs and removing any foreign material carried in with the dust. On some machines there is a tendency for air from the air duct to be blown back through the feeder into the hopper. In cases where this is true, the hopper should be made air-tight to prevent the dust from being blown out. Where gear or chain drive is necessary to operate the feeder, agitator, etc., it should be of the best quality of material and workmanship. A great deal of trouble has been experienced from this source owing to the presence of dust and dirt both in tooth and sprocket gear mechanisms. Ordinary rough-cast gears and detachable link chains absorb considerable power and wear easily. The chains, in particular, if slightly worn and of much length, invariably start riding the sprockets and running off. Also it is a common occurrence for the operator to remove too many links and run the chains too tight, which is not only apt to break the chain but will also cause excessive wear on the sprockets and bearings.

LIGHTING.

The question of an adequate and serviceable lighting system is one that is not settled at the present date. The lighting apparatus, like the rest of the machine, must be simple. The requirements are that the light be strong enough to enable objects to be clearly distinguished at a reasonable distance, say 50 feet, particularly in the front and rear, for it is necessary for the operators not only to be able to distinguish the rows clearly in front but to see the dust cloud in the rear and to have plenty of illumination on the machine parts. The height of the burner of any light should be at least 36 inches from the platform in order to reduce the shadow of the platform and thus enable the driver to drive around obstructions with greater safety. Where it is necessary to use reflectors, the widest angle possible should be used in order that the light may be distributed to all sides of the machine.

Various lighting systems have been tried, but all have met with serious objections. Several types of carbide generators, such as were formerly used on automobiles, were tried and gave good light when in working order, but too much trouble was experienced with the generating systems due mostly to the fact that the water feed was unreliable. This was largely due to clogging of the wicks and the difficulty of cleaning and replacing them. Variation in the size of the lumps of carbide also caused trouble by irregular feed through the screens which produced an objectionable variation in the gas supply.

Experiments have been conducted on a light using a compressed carbide cake. This light has been found to be very satisfactory, and it is believed that it will meet requirements in the field. It furnishes plenty of illumination, is automatic in control, and comparatively simple. The light is so constructed that the carbide cake is held in a container which is open at the bottom end and is submerged in water. When water comes in contact with the cake, gas is generated inside the container, producing a pressure which forces the water down and away from the cake until enough of the generated gas is used to lower the pressure to a point where the water again rises to contact with the cake, and gas generation again takes place. The carbide cakes are specially treated to prevent deterioration when exposed to the atmosphere, and are convenient to handle when the light is being charged. This light uses a reflector especially designed to meet the requirements of this work.

Gasoline lanterns equipped with mantles and pressure systems were tried, but the mantles proved too fragile to withstand the constant vibration to which they were subjected. Various spring mountings for these lanterns were tried, but did not prove effective, the principal difficulty being that a light spring which would absorb the engine vibration was too light to resist the heavy shocks experienced on rough land. Even with the engine removed, however, it was not possible to arrange a combination of springs which would protect the mantles. It is especially unfortunate that these lights can not be used, as they furnish an abundance of illumination in all directions and thus eliminate the necessity of reflectors, which is a very desirable feature. They are also quite easily detached from the machine for refilling or for other uses.

Compressed acetylene gas systems have given the best satisfaction from the standpoint of reliability, but for this particular work have, in addition to a rather high first cost, another very objectionable drawback. It is absolutely necessary to have at least two tanks for each machine and preferably three, in order to have a supply of gas on hand at all times. The cost of these tanks at the present time is approximately $20 each, which, added to the cost of necessary reflectors, makes the total lighting cost close to $75 per machine, which is too high. The question of getting tanks refilled is a serious one and practically eliminates the adoption of this system of lighting for general use. Since automobiles have almost universally adopted electric lighting systems, filling stations are becoming very scarce. Considerable time is taken up when the tanks are in transit; also, as a rule the recharging stations do not send a full tank until an empty one has been placed in the hands of the express company and the express receipt received by them. If the plantation is remote from the express office, considerable inconvenience is caused by the necessity for making trips to the express office to get the filled tanks and return the empty ones. During the busy season when the dusting is being carried on planters are unable to stop work and make a trip merely to get a tank.

It seems reasonable that some form of electric lighting could be utilized but when all the conditions are considered many points come up which appear to make it impracticable, although a system may be devised which will work successfully. A small generator could be installed on the machine to give satisfactory illumination when the machinery is running, but lights are necessary when moving from field to field and when the machine is undergoing repairs at night. A solution of this difficulty of course would be to use a storage battery, but considering the class of labor which operates the machines, this is out of the question. It also looks feasible to use dry cells with an extra set of lights for furnishing illumination when the generator is not running, but this would complicate the lighting system by increasing the number of parts and there would be trouble as a result of failure to provide extra dry cells and care for them properly.

DISTRIBUTING SYSTEM.

Considerable trouble has been experienced in getting a satisfactory system of carriers for delivering the dust to the plant rows. At the start these systems were built of ordinary iron pipe and fittings which proved unsatisfactory in many ways. The pipe was heavy and the use of the fittings objectionable in that they introduced irregularities which caught dust and caused the formation of drifts which eventually clogged the pipes. All turns were made with right-angle fittings which gave a great deal of trouble, not only from the dust sticking in them and their resistance to the air blast but from the working loose of the screwed joints. These in many cases were drilled and riveted to prevent this tendency to work loose but this was not satisfactory, as the excessive vibration would either shear the rivets or enlarge the holes and cause trouble in that way. The main pipes led away at right angles from each side of the fan discharge pipe, and smaller lateral pipes led from these to the nozzles. This arrangement made it necessary on three of the nozzles to use two right-angle bends, one from the fan discharge pipe and one where the lateral or nozzle pipe joined. On the line to the outside nozzles only one right-angle bend was required, as these pipes were a part of the main line and were bent with a gradual curve which brought the nozzles into their proper position; thus the only short bend was at the fan discharge pipe.

Rather extensive experiments were conducted to find a system which would eliminate sharp bends and give an even distribution of the dust which was not possible with the straight pipe and right-angle bend construction, since the end and center nozzles discharged the greatest quantity of dust, while the two intermediates discharged the least quantity. To form the most satisfactory dust cloud it is desirable to have the two end nozzles give the heaviest discharge, with those inside decreasing their discharge to the center where it is lightest, the reason being that there is always a tendency for the dust cloud to drift more or less. Consequently, some of the cloud coming out of the end nozzles drifts toward the center, and in order to get the density uniform the discharge of the center and intermediate nozzles should be less than that of those on the end. In order to accomplish this a distributing box or chamber was built and attached to the fan outlet. This box had outlets for the five discharge lines. Between the outlets were adjustable partitions which could be set to divert the desired proportion of dust to the different nozzles. Rubber tubing was used for the discharge lines. This tubing was carried to the nozzles by means of framework built up of angle irons in such a way that they would permit raising and lowering the nozzles, as well as allowing the end nozzles to be folded in against the side of the platform for moving.

Tests were made on the straight pipe system where all the laterals leading to the nozzles were the same size (1¼ inches in diameter) and it was found that 26.64 per cent of the dust went through each end nozzle, 18 45 per cent through the center, and 13.13 per cent through each intermediate. It was found that by decreasing the size of the center pipe from 1¼ inches to 1 inch the distribution was more nearly what was desired. This changed the results so that the discharge from the different points was as follows: End nozzle, 28.45 per cent; center nozzle, 13.32 per cent, and intermediate, 14.84 per cent. Where the distributing box with the adjustable partitions was used it was possible to get any adjustment desired from complete cut-off of any pipe to its maximum carrying capacity.

Difficulty has been experienced in getting satisfactory construction of the framework for carrying the distributing systems. As before stated, they are subject to much vibration and shock and must have some sort of a hinge to permit the end sections to fold in, or a method of unjointing them so that they may be carried on the platform when necessary. If constructed to be unjointed, too much time is consumed in tearing down and reassembling. Where hinged joints have been provided they have in all cases been too weak, with the result that a great deal of breakage occurred.

The elevation of the nozzles was regulated by swinging them through an arc of 90°, or from a horizontal position for tall cotton to a vertically downward position for the small cotton. The nozzles were controlled and held at any desired height by means of levers. On some machines separate levers were provided for controlling the nozzles on each side of the fan discharge. This, however, is not as satisfactory as having a single lever which will control the entire system. A difficulty experienced has been a tendency toward too light construction of this controlling mechanism, as it must absorb a large part of the shock from the vibration and bouncing of the whole distributing system. The greatest trouble has been with the clamps which attach the pipe to the hand lever. These clamps, as sent out from the factory, have invariably broken or slipped on the pipe and the only satisfactory remedy has been to replace them with larger ones made at the local blacksmith shop, and even these have a tendency to slip on the pipe. This difficulty can be remedied by some type of positive fastening of the clamp to the pipe. Owing to the frequency with which it is necessary to elevate the nozzles very quickly to prevent them from striking some obstruction, all machines must be provided with some positive and infallible lifting device.

The nozzles on the original machines were not constructed for night operation when dew was on the plants; and they did not distribute the dust to the best advantage, in that most of it was blown straight out from the center of the nozzle instead of being spread out fan shape to cover the largest area possible. To overcome these difficulties a nozzle was designed with a flaring lip or bell on the outer end to prevent the throat or slot, through which the dust emerges, from coming in contact with the wet plants. To get a better spread of the dust two deflecting partitions were put in the nozzle and so placed that they caught the correct proportion of the dust and spread it through the entire nozzle. The positions of these partitions were determined by experiment, and no changes in the adjustment were ever required. Some of these nozzles were made of cast iron and proved too heavy, owing to the additional strain placed on the piping and framework. They were also quite easily broken on striking any obstruction. In many cases they were broken by the operators during the process of thumping to jar loose any collection of dust which might have gathered in them. Nozzles made of pressed sheet metal have the advantage of being comparatively light and are able to stand much rougher usage than those of cast iron, and when damaged can often be bent back into serviceable shape. In making a nozzle all square corners should be avoided, as they catch dust and start drift formation.

EXHAUST.

The difficulty experienced with some machines in keeping the dust from lodging in the piping and feeder was relieved by connecting the engine exhaust to the fan discharge pipe immediately beyond the take-off from the fan, where the force of the exhaust would strike the feeding mechanism and keep it clear. The impulse also would keep drifts from forming at bends and irregularities in the piping. When inflammable compounds are being used as insecticides this scheme should be avoided, as it is possible for particles of hot carbon or flames from the exhaust to ignite the dust and cause an explosion. The adjustable distributing box, the improved nozzles, and the idea of connecting the exhaust to the fan discharge are all covered by Government patent No. 1282697 and are available for free use by all.

ADVANTAGES AND DISADVANTAGES OF THE POWER DUSTERS.

From the general ideas given of the conditions to be met, the advantages and disadvantages of the power machines may be summed up as follows: They are capable when working properly of covering a large acreage in a short time, for an acre can be treated in about 10 minutes; also, there is room on the platform for carrying a good supply of dust, it being possible not only to keep a 200-pound barrel on the machine when operating but to tie on two or three additional barrels when going to the fields. On the other hand, they are heavy, weighing approximately a ton, and rather cumbersome to handle as field machines. The four wheels do more or less damage to plants in turning at row ends and in getting around obstructions in the field. The numerous parts of both the truck and dusting machinery require close attention and a fair knowledge of mechanics to keep them in working order. Experience of the past two years has proved that the average laborer available is not capable of caring for and operating the engine properly, and that he can not be depended upon to locate trouble or make adjustments and repairs. The distributing system when carrying five nozzles is awkward to handle around obstructions and in turning close to fences. Then, too, considerable time is consumed in getting the machine in shape for moving and in reassembling it for a new start.

WHEEL-TRACTION DUSTER.

The many difficulties experienced with the power duster emphasized the need of a more simple machine which would eliminate as many of the objectionable features as possible and still give the service. The idea in mind was to avoid the use of an engine, reduce the weight of the machine, and make it possible for the driver alone to operate the machine. Consequently, in 1919, an experimental machine was built and tested which incorporated these ideas. This machine, as can be seen in figure 5, is a two-wheel, arched-axle cart duster, with the power furnished by the traction wheels, which have sprocket chains running from them to drive a jack shaft on the cart platform. This jack shaft carries ratchets on the ends, and a friction clutch through which the power is transmitted to the mechanism for operating the fan and feeder. The ratchets on the ends of the shaft engage the small sprocket wheels and permit the traction wheels to run backward without turning the shaft, so that when turning at the row ends one wheel can drive the shaft and keep the machinery running, thus giving a continuous flow of dust. The friction clutch permits starting the machinery gradually, thus avoiding sudden strains and a heavy starting load on the team.

The fan and dust hopper are exactly the same as those used on some of the power machines, the only changes being the use of a V belt for the fan drive to secure good contact, and the positive auger feed previously mentioned which insures a steady flow of dust. An iron pipe distributing system carrying three nozzles, but otherwise similar to that on the power machines, was used. The end sections of this piping were made removable to allow the machine to go through any opening that the tread would permit.

This duster, although constructed merely to try certain principles, was put in the field and operated continuously throughout the dusting season with very satisfactory results. The load on the team was not more than that of pulling the power machine. Comparatively little time was lost in making repairs or adjustments. One man drove and operated the machinery without difficulty. During the season's run this machine covered as large an acreage as the power machines, for since it carried only three nozzles it was much more easily moved from field to field and made closer and quicker turns at row ends and around obstructions, with less damage to the plants. No time is lost from engine trouble or in looking after numerous truck and distributing system parts. The distributing system with only three nozzles permits lighter construction and, being comparatively short (9 feet from center to center of outside nozzles), is subject to much less breakage than the distributors on the power machines where the distance is 18 feet between outside nozzles.

Another feature of this machine is that, since the feed auger is operated by the traction wheels, the rate of feed is always proportionate to the speed of the team, thus giving an even distribution of dust at all times. Even when turning at the ends with one wheel doing most of the driving, a sufficient dust cloud is discharged to cover the plants effectively.

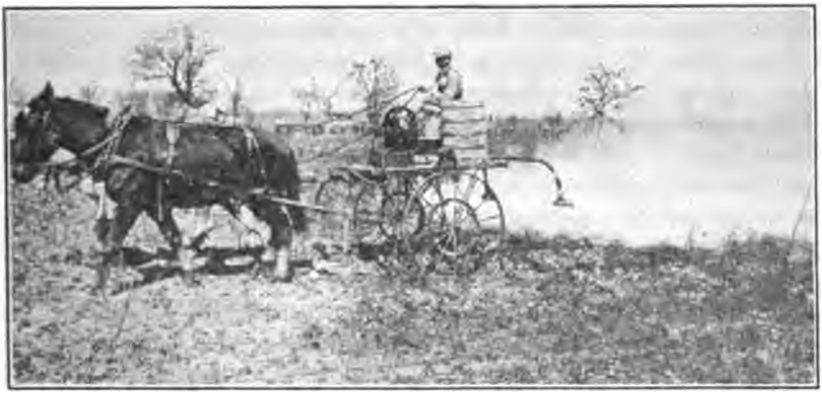

FIG. 5.—Wheel-traction machine in operation in a cotton field.

In designing a cart duster careful consideration should be given to every part. The traction wheels should be high enough to give easy traction with a tire width to allow plenty of ground contact. The hub should be equipped with roller bearings to prevent the excessive wear which would throw the sprocket drive wheel out of alignment and cause chain trouble. All chains preferably should be of the roller type, with the drive chains protected by guards or shields to prevent them from coming in contact with the plants, and to keep out as much dirt as possible.

The arrangement of the machinery on the platform should be such that it will use a minimum of space, for room is necessary for the driver's seat, the lighting system, and a 200-pound barrel of poison. The size and location of the platform with respect to the axle should be such that the load is balanced to prevent excessive weight coming on the horses' necks and yet not so far back that there will be objectionable tipping upward of the tongue when going down hill with the machine out of gear or when crossing ditches.

The neckyoke and doubletree should be of arched construction to give clearance over the plants. The doubletree, or whatever method of hitching is used, should be so constructed that the duty of pulling the whole load can not come on one horse without being detected by the driver.

With this machine the question of tread and axle clearance is probably even more important than with the power machine, since, having only two wheels, it would, with a high axle and too narrow a tread, have a tendency to be top-heavy and tip over easily. Generally speaking, however, in the districts where the cotton is planted in narrow rows the plants are comparatively small and the height of the cart can be reduced in proportion to the tread required. This will probably result in the production of several sizes of machines adapted to the different districts, but for the present the plans are for the production of a single size of machine having a 48-inch tread and a 42-inch axle clearance. This will undoubtedly serve in any cotton having a row width of more than 36 inches, and for the present it seems best to avoid the treatment of the cotton planted in narrower rows, as it is generally rather low in total production per acre and also subject to comparatively light weevil injury. Until poisoning has advanced further beyond the experimental stage better results can be secured by confining the work to the cotton where there is the greatest loss in production due to the weevil, and this is nearly always found in the districts where reasonably wide rows are used.

Attention has also been given to a machine which would straddle two rows and carry four nozzles, but this duster would require a very wide hitch and would be very difficult to handle in the field.

Consideration has been given the idea of building a machine with an adjustable axle which would allow variations in both height and width, but this is objectionable in that the many parts thus required would increase the weight and weaken the construction more or less. Furthermore, such an arrangement would undoubtedly be so complicated that the labor available for operation would have great difficulty in making adjustments.

SUMMARY AND CONCLUSIONS.

Experiments for the past few years in poisoning cotton for boll-weevil control have shown that profitable results can be secured on a practical basis if correct methods are followed. It has been found, however, that the poison must be applied in the form of a dry dust and that much of the success of the operation depends upon the dusting machinery available. Consequently, in either constructing or purchasing machinery for boll-weevil control it is necessary to consider carefully the many requirements of the work in order to make sure that the machinery will serve the desired purpose. The extent of weevil-infested territory is so enormous and the interest shown by the planters so great that with the present facilities for the production of dusting machinery it is going to prove impossible to meet the demand. Consequently, every effort should be made toward making all machines which are put out for the market as satisfactory as possible and, furthermore, all farmers should inform themselves thoroughly on the requirements of a satisfactory dusting machine, so that in case an unsatisfactory machine is offered, they will be able to detect its faults in advance of purchase, and thus protect themselves from loss and possible failure of the poisoning operation. In case of further questions not covered by the present bulletin, all are invited to correspond with the Delta Laboratory at Tallulah, La., and the best advice available will be gladly furnished.

It has been found that cotton dusting differs radically from the operation of any other insecticide treatment now utilized, and that quite a number of special factors control the construction of the cotton-dusting machine. These are: (1) Type of labor; (2) areas to be treated, both in plantation and in field; (3) field conditions, such as row length, stumps, etc.; (4) necessity of night operation; (5) characteristics of poison utilized; and (6) type of dust cloud required. All of these factors affect so decidedly the operation of cotton dusting that unless the prospective manufacturer studies them carefully and thoroughly understands them, he can not expect to build a dusting machine which will prove satisfactory in field service.

The various types of machines, including hand guns, wheel-traction dusters, and power machines, have been tested extensively and the foregoing pages explain in detail the difficulties which have been experienced in the operation of each type of machine and the steps which have been taken to overcome these difficulties, as well as suggestions for additional measures which may be taken in the future. Experiments to date have indicated that the hand gun has a decidedly limited use. The treatment of considerable areas (that is, over 50 acres) with a number of hand guns has not proved practicable under most conditions. Consequently, once an adequate supply of dusting machines is available, it seems that the use of the hand gun will be limited to exceedingly small areas of cotton and as an adjunct to large machinery. The power machines have proved fairly satisfactory but the desirability of eliminating the engine has become so pronounced that the present tendency is to favor the wheel-traction machines which have been described in some detail.

It must be understood, of course, that the present bulletin is to be considered only as a progress report and is issued solely for the purpose of making available the information on the subject of dusting machinery which has been secured so far. The writers do not wish to be construed as intimating that the statements and conclusions given in this paper are in any way final. Dusting machinery for cotton poisoning is strictly in an experimental stage and it is to be expected that improvements will be developed from time to time for years to come.

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FARMERS' BULLETIN 1098

UNITED STATES DEPARTMENT OF AGRICULTURE

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FARMERS' BULLETIN 1099
UNITED STATES DEPARTMENT OF AGRICULTURE

HOME LAUNDERING

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CLEAN CLOTHES are as necessary as clean food to health and comfort.

Much of the drudgery that has so long been considered a part of laundry work may be overcome by using good supplies, providing proper equipment, and following the best methods.

If the housewife will plan a room for her laundry with as much care as she does her kitchen, and then give the same amount of thought to putting in proper equipment and working out good methods, she will save much hard work.

Contribution from the States Relations Service
A. C. TRUE, Director
Washington, D. C. June, 1920

HOME LAUNDERING.

Lydia Ray Balderston,
Instructor in Laundering, Teachers College, Columbia University.

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WASHING AND IRONING are among the hardest of the regular household tasks, and ways of lessening the work are much needed in many homes. The ideal of every housekeeper would be a separate room for her laundry, with running water and modern labor-saving devices. These can not be provided in every home, but even where the arrangement and equipment are necessarily very simple it is often possible to make minor changes or to plan the work in such a way that it will take less time and strength. Probably not many households could adopt all the conveniences and methods described in this bulletin, but if the housekeeper follows the suggestions as far as her resources and circumstances permit, she may be able to make the weekly washing less burdensome.

THE LAUNDRY ROOM.

In olden days, tubs and wash benches were brought into the kitchen because water could be heated there most conveniently, and from this seems to have developed the idea that the kitchen is the place for the laundry. The odors and steam from laundry work, however, are disagreeable in a kitchen, and the handling of soiled clothing in any room in which food is prepared is highly objectionable. If clothes must be washed in the kitchen, the preliminary sorting should be done elsewhere.

In some sections, especially in the South, it is considered preferable to have the washing done out of doors or in a room outside of the house. Otherwise the best place for a laundry is usually either in a room next to the kitchen or in a basement room directly below it, because this makes it possible to use the same chimney and if the house is equipped with running water the same water pipes for both rooms. A basement laundry generally means too many stairs for the housewife, while a room adjoining the kitchen may enable her much more easily to carry on or oversee the work in both rooms at the same time.

Good lighting is necessary for good laundry work, and tubs and ironing board should be so placed that the light comes from the side. Direct sunlight is blinding. Putting glass in the door is often an inexpensive way of increasing the light. If clothes are to be hung outside, a door should open directly from the laundry to the yard. Doors and windows should be arranged to give the thorough ventilation especially necessary because of steam, odors, and heat.

A laundry floor should be of material that wears well, is not too hard for the feet, does not soak water or get slippery when wet, and is easily cleaned. Wood, cement, composition, and linoleum are used. Wood floors are not easily cleaned and are often slippery when wet. Georgia pine, a wood often used, is resinous, making it resist water and wear well. A maple or other hardwood floor wears better but is likely to be more expensive. Cement floors are common in some parts of the country and relatively inexpensive, and if painted with special cement paint they do not absorb water. Some composition floors are not too hard, are less expensive than hardwood, and are easily cleaned. The "composition" may be spread over an old wood floor. A floor covered with linoleum is easily wiped up, is impervious to moisture, and is easy to tread, but is slippery when wet. Such a floor will be more durable if the linoleum is cemented down and the seams are filled with waterproof cement.

The walls should be light in color and should be treated in such a way that they are not affected by steam. Oil paints are preferable to water color. If two coats of flat house paint and then two of enamel oil paint are used, the walls will be washable.

The room should be divided into a washing and an ironing section. The position of the stove will determine the details of this division. To make boiling the clothes convenient, the stove should be near the tub. If a washing machine is to be used, the tub should be so arranged that the garments go directly, without handling, from the machine through the wringer to the tub, and vice versa. If the arrangement is well planned, one washtub will be sufficient with a washing machine.

A closet or cupboard for holding supplies is almost a necessity. A good place for the closet is between the part of the room holding the washing outfit and the part reserved for ironing. The closet should preferably be high enough to hold the ironing board (unless it is permanently attached to the wall) and large enough to hold all the necessary equipment. One part of the closet may be shelved to hold the wringer, washboard, starching equipment, irons, soap, bluing, etc. Lists of such equipment and supplies are given on pages 14 and 29.

EQUIPMENT.

Good equipment is as important as right methods in laundry work. Both decrease the labor, shorten the time, and assist in producing better results. Equipment need not be expensive, but it should be chosen and placed from the point of view of service and for the comfort of the worker.

The working surface of nearly all laundry equipment is usually set too low, and the woman operating it is so out of balance that she is soon fatigued. Little of the washing process is done in the bottom of the tub, and the working height is about half-way up the side. For the average worker the top rim of the tub should be 36 inches from the floor; in all cases the tubs should be placed so that the worker does not stoop from the shoulders but bends at the hips. A portable washtub may be easily raised or lowered to the right height. If the top of the washboard is too high, it may be lowered by cutting off part of the legs. The ironing table or board should be low enough so that force from the shoulder can be easily applied; 31 inches is a good average height.

Where no special room is provided for the laundry and there are no set tubs, a portable bench of the correct height and size is convenient.

TUBS.

A wooden tub is difficult to keep in good condition. If kept dry it is likely to shrink and fall apart; if kept moist enough to prevent shrinking, it is likely to become water-soaked and slimy, and may have a disagreeable odor. A portable, galvanized-iron tub is fairly light, durable, and easy to keep clean, but may corrode. A fiber tub is still lighter, is easily kept clean, and is durable if left dry, but is more expensive than an iron tub. Any portable tub may have a hole bored in it and a plug inserted so that water may be drained from it without lifting the tub. Hot and cold water can be piped to a portable tub as well as to a more expensive stationary one.

For set tubs, wood, which is now little used, has the same qualities as for portable ones. Soapstone and similar materials are cheaper than porcelain, but because of their dark color it is more difficult to be sure that they are clean. Porcelain or enameled-iron tubs are heavily glazed and do not rust or absorb grease. Both white and yellow porcelain tubs are on the market; the latter are cheaper but the color may make it hard to tell when the clothes are white. A home laundry is most often equipped with two tubs, but when there is no washing machine a third tub saves much handling of the clothes.

WASHBOARD.

Washboards reduce the work of cleaning a garment but are somewhat hard on the clothes. A glass board, although more easily broken, is preferable to a metal one, because the corrugations are rounded and the friction on the clothes is less. When the surface of a washboard is broken it should not be used. Washboards should always be put away dry so that they do not warp or attract waterbugs.

WRINGER.

Wringers save labor, make the clothes much drier, and are less destructive to fabrics than hand wringing. To prevent buttons from being torn off by a wringer, fold them into the garment and hold it flat. A reversible wringer is much more useful than a one-way wringer if two or more tubs are used. To keep a wringer in good condition it should be oiled with good machine oil and the pressure screws should be loosened when it is not in use. When the pressure is put on again, both screws should be turned at once; then the pressure is more likely to be even. The rollers of a wringer may be cleaned with a cloth moistened with two or three drops of kerosene; but, since kerosene dissolves rubber, the rollers should be washed with soap and water as soon as the discoloration disappears.

CLOTHES BOILER.

A tin boiler costs less than any other, but is not particularly durable. It must be well dried after using. A tin boiler with a copper bottom is more durable, conveys heat better, and is worth the additional cost. A boiler made entirely of copper is expensive, but is the most durable of all. Some elaborate laundry equipments have stationary boilers, which save much lifting.

WASHING DEVICES.

Some helpful washing devices are on the market. One is a perforated funnel, made to place in a wash boiler, which works on the same principle as a coffee percolator, spraying the clothes and increasing the circulation of the water. The funnel-on-a-stick washer creates a partial vacuum and makes it possible to wash more clothes at a time and also to wash very soiled clothing without immersing the hands or scrubbing.

WASHING MACHINES.

Washing machines, whether operated by hand or by motor, are efficient because they do more work in a given time and do much of it without direct and constant supervision. While wooden-tub machines are cheaper than those with metal tubs, they are likely to dry and then leak, if kept in a heated room; it is better to store them in a cellar, a barn, or a shed, or on a porch. Leaving a wet sponge in the machine helps to provide moisture. Metal tubs must be protected against rust, and the working parts of all machines must be kept properly oiled.

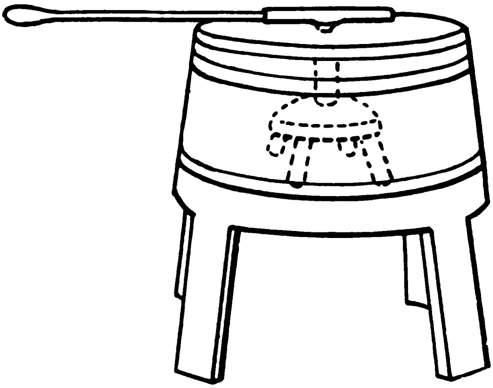

Fig. 1.—Dolly type of washing machine.

Types of washing machines.—While there are two hundred or more washing machines on the market, they may all be grouped under five heads:

(1) Machines of the "dolly" type (see fig. 1) have a device like a short-legged stool that revolves in a tub, usually of wood, and cleans the clothes by drawing them through the soapy water, first one way and then the other. In some cases there are corrugated boards around the side of the tub. There is special danger of tearing the clothes if too many are put in at one time.

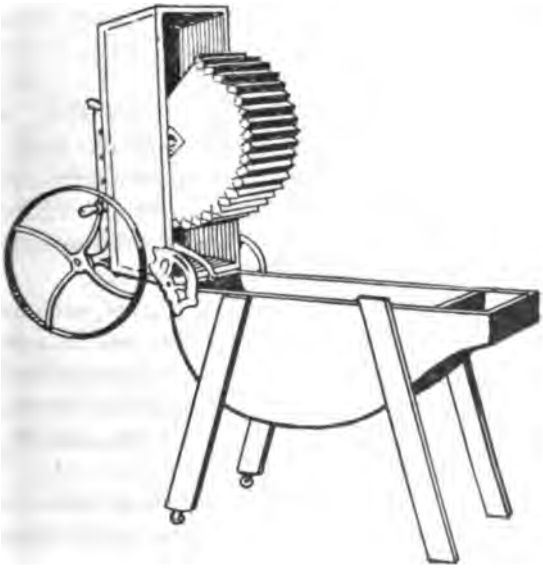

Fig. 2.—Washboard type of washing machine.

(2) The "washboard" type of machine (see fig. 2), like the "dolly," usually has a wooden tub and rubs the clothes between corrugated boards.

Both these types of machines use friction and so are better suited for washing heavy, coarse clothing than for more delicate fabrics.

(3) The "cylinder" type of machine (see fig. 3) has a revolving perforated cylinder that holds the clothes and rolls barrel-fashion in an outer cylinder, which holds the soap and water. The better makes of this type reverse the action, because a continual revolving of clothes in one direction twists them, thus preventing the water from being

so easily forced through them and increasing the work of removing the dirt.

(4) The oscillating type of machine throws the clothes forward and backward in an elongated box.

Both cylinder and oscillating machines are good for general home use, because in them the clothes are not pulled nor rubbed.

(5) The vacuum type of machine (see fig. 4) is equipped with cones or funnels that first press down on the clothes and then lift, producing suction. They are sometimes spoken of as the "pressure and suction type.

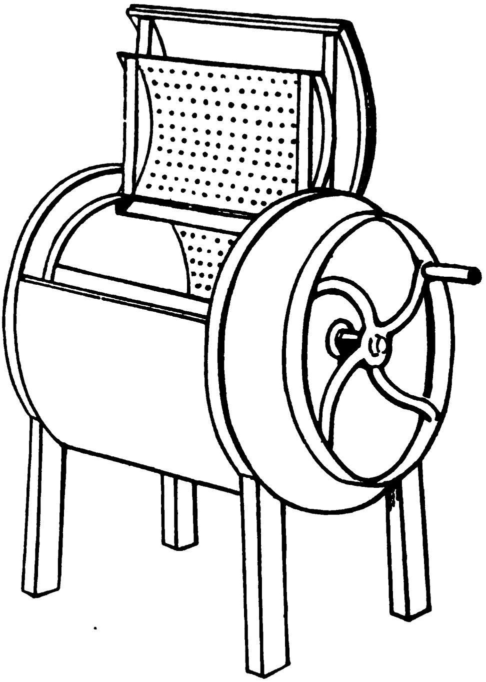

FIG. 3.—Rotary, or cylinder, type of washing machine.

Motors.—All these types of machine may be operated by hand or by water, gasoline, or electric motor. While a motor will increase the price of the washing machine, it will save much time and labor.

A water-motor washing machine may require a considerable flow of water. If a water flow of about 40 pounds pressure to the square inch is available, a water motor may be used; but may not be economical if the water is metered. There are some new machines that run on lower pressure.

A gasoline engine, such as is used to cut fodder, grind corn, or pump water may be used to run the washing machine. The belts by which the power is transmitted should be kept taut. Every person who runs a sewing machine knows how much power is wasted in treading when the belt is loose, and the principle is the same with the gasoline engine.

Electric machines may be purchased with motors using either a direct or an alternating current. Before the housekeeper orders her machine she must find out which kind of current is available, because even in different parts of the same city various kinds of electric current may be used.

Plugs are standardized; therefore if the connection is to be made through an electric-light plug, no special attachment will be needed

In building a new house in which electric machines are to be used, it is wise to place plugs in the wall and not to depend upon the lighting system. Some localities give two service systems, one for lights and a cheaper one for operating electrical appliances.

In order to determine whether, from the money standpoint, it is cheaper to wash by hand or to buy and operate a washing machine, the cost of the two methods may be reckoned as follows: Divide the cost of the machine by the number of years it will probably be used. To the result add the cost of operation (about 5 cents an hour multiplied by the number of hours it will be used in a year, plus about $1.50 per year for oil and minor repairs). To reckon the cost of hand work, calculate the amount paid a laundress during the year for actual washing (not starching and ironing) and add the yearly cost of any meals and car fare given her; or, if no laundress is hired, multiply the number of hours you give to this work yearly by the price which a laundress receives per hour in your neighborhood.

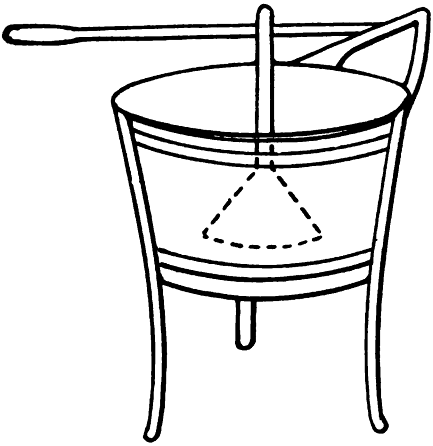

FIG. 4.—Pressure and suction type of washing machine.

STARCHING OUTFIT.

The starching outfit consists of a pan or a pail, a tablespoon, a teaspoon, a measuring cup, and a strainer. All of these may be borrowed from the kitchen, but a duplicate set is inexpensive and time is saved by having it at hand.

CLOTHES BASKETS.

Baskets are used both for carrying wet clothes and for holding the soiled clothes that collect during the week. Those used for the latter purpose usually have a cover and are spoken of as hampers. Clothes baskets must be kept clean; therefore it is well to line them with some washable material, such as oilcloth or muslin, or with heavy paper that can be readily renewed. The clothes basket is usually of wicker, but hampers for holding soiled clothes are now also being made of papier mâché, which can be easily washed and dried. Bags made of material that may be washed and boiled with the clothes each week will answer the same purpose as the hamper. Infected clothing should never be put into the general hamper or the bag, but should be given special treatment (see p. 22). Damp clothing should be dried before it is put into a hamper or bag.

CLOTHESLINES AND CLOTHESPINS.

The common clotheslines are hemp rope, galvanized wire, and cloth-covered wire. Rope lines are cheapest, but they should be taken down when not in use. The wire lines are durable, but with long use they are likely to corrode and stain the clothes.

The old-fashioned wooden clothespin is cheap and very serviceable for general use provided it is made of sound, smooth wood. The metal wire in spring clothespins is likely to corrode and may break.

CLOTHES DRIERS.

If she can get clean, fresh air and sunshine, every laundress prefers to dry her clothes out-of-doors. Unfortunately, in many city homes, and in bad weather anywhere, this is out of the question, and some provision must be made for indoor drying. Clothes driers vary greatly in type. An excellent kind of drier for the small home is the one that is easily pulled up to the ceiling; it takes up so little room that it can be used in the kitchen if this is the only place available. For larger establishments specially heated space is sometimes provided; for example, a metal closet built in a small room adjoining the kitchen and heated by a radiator or an extension of the stovepipe. These inclosed driers must be ventilated to allow the steam to pass off; otherwise the clothes may be yellow.

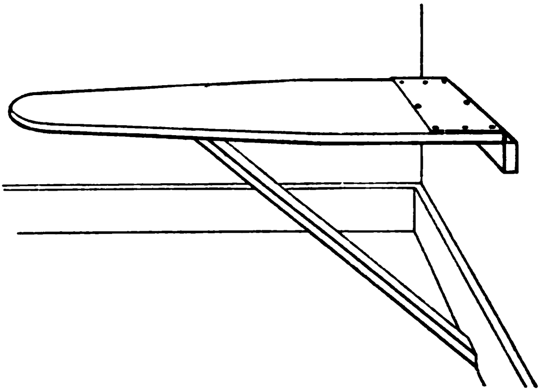

FIG. 5.—Folding ironing board.

In fitting up a special room as a laundry, even in a small house, it might be advisable to look into the question of the expense of installing a combination drier and stove. In such a drier the heated air passes through it from the stove just as the hot air in a cookstove is forced around the oven. The top of the same stove may be used for the wash boiler and the irons.

CLOTHES SPRINKLERS.

Elaborate clothes sprinklers are on the market, and there are cheaper devices which give equally good service. An excellent one consists of a sprinkler attached to a cork that may be fitted into a medium-sized bottle. The fine sprayer that can be attached to a small hose is good, but costs more than the bottle sprayer. Whisk brooms make good sprinklers, the round ones being perhaps more suitable for this work than the flat kinds. All these devices should give a finer spray, should sprinkle more evenly, and should do the work in less time than the hand method.

IRONING BOARDS.

An ironing board should stand firmly. A board with its broad end hinged to the wall is very convenient (fig. 5). Directions for making such a folding ironing board are given in another bulletin of this series,[1] which also tells how to make a rack to hold a portable ironing board (fig. 6) on the wall or the inside of a closet door.

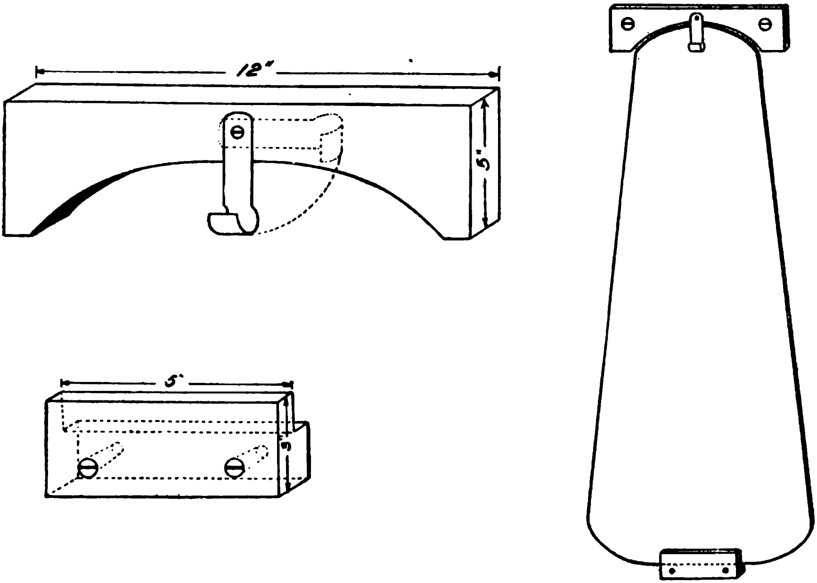

Fig. 6.—Rack for holding ironing board.

If the smaller end is square, the board is useful for ironing shirts and takes the place of the old-fashioned bosom board.

An ironing board should be padded so that it has spring, but not so that it is like a cushion; if padded too much, the iron will sink down and mark the garment that is being ironed. Heavy felt or the double-faced cotton flannel such as is used on a dining table, makes an especially good pad for an ironing board, but is expensive. The width of this material will cover the length of the board. The pad should be wide enough to turn over the sides, and about 2 inches should be allowed on all sides for shrinkage. Two thicknesses of the new material will be enough for a board, but after the pad has been washed or flattened by ironing three thicknesses will give better results. Old blankets and mattress pads may be used, but by the time they are worn enough to be discarded for use on the bed they are usually too matted down to be of great service on the ironing board.

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[1] U. S. Dept. Agr., Farmers' Bul. 927 (1918), Farm Home Conveniences, pp. 13, 14.

The cover on the ironing board may be made of old sheets, but is better made of new heavy unbleached sheeting 60 inches wide. This allows the width of the muslin to form the length of the cover. The cover should be hemmed and four pieces of tape firmly sewed to each side so that it can be easily put on and taken off. Ready-made covers laced together through eyelets are also convenient. There are various spring devices for holding the cover together, but some of them are likely to tear it.

A sheet of asbestos placed under the iron rest and the paper or cloth used for cleaning the iron, protects the muslin cover from scorching. Some boards have a piece of tin about 8 inches wide tacked across the end on which the iron is to stand.

IRON HOLDERS.

Iron holders should be thick enough to protect the hand, but not bulky. Ticking and asbestos are used in the ready-made holders, but folded stockings or newspapers covered with denim, gingham, or ticking make good holders. The alternate use of two holders will be found comfortable and convenient.

IRONS.

If old-fashioned flatirons are used, at least three should be provided. This allows a change of iron often enough to rest the hand and keep the irons hot. Those weighing from 6 to 8 pounds are easier to use than lighter ones, because a heavy iron makes it unnecessary to exert so much pressure. It is convenient to have one light-weight iron for thin goods and a sharp-pointed one for ruffles and gathers.

Flatirons with patent wood handles are convenient, but do not hold the heat so well as the old-fashioned iron. They are less likely to be steady and are not made in so many different shapes.

Electric, gas, gasoline, and alcohol irons save the worker from standing near a fire and from walking back and forth to change irons. They also make it possible for her to sit while ironing plain articles, and thus make the work easier. At first thought the price of these irons may seem prohibitive, but the convenience is so great that the initial cost and the cost of operating may be justifiable.

In buying an electric iron, choose one made by a recognized electrical supply company. This iron should be guaranteed for a year. The voltage of an electric iron is marked on the back of it and is, in most cases, 110. The housekeeper must choose an iron that corresponds in voltage with the home current, because if more current is forced through than the wires are able to carry, it will be "burned out." The electric wires that lead from the iron should be watched; if any break appears in the covering it can easily be mended with adhesive tape while the current is off. These breaks should not remain uncared for, because of the danger of shock and fire.

Gas, gasoline, and alcohol irons burn fuel within the iron. Care must be used with the last two because if the container leaks, fire will result. With a gas iron the tubing connecting the gas is likely to knot and twist; therefore it is wise to choose the so-called flexible tubing, either the kind wound with wire, or, better still, that with a flexible metal core covered with several layers of protective material.

Rusty or dirty flatirons should be scoured with sand soap or other rough material, washed and wiped dry, heated and waxed, and the surplus wax rubbed off on a clean cloth. If the iron is hot, it may be waxed and then rubbed on salt, sand, or emery paper. Electric and gas irons can also be cleaned in this way, but care should be taken to avoid wetting the insulated wires of an electric iron. New irons should be waxed before using. Irons not to be used for some time should be protected from rust by a coating of grease or paraffin or by wrapping them in waxed paper.

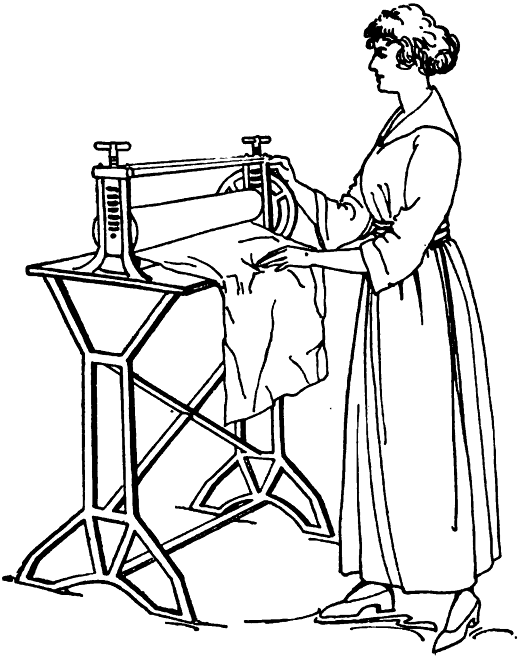

FIG. 7.—Cold mangle.

IRONING MACHINES.

A mangle or ironing machine is of great help; if one can not afford both that and a washing machine, one should get the latter first, because there are more clothes to wash than flat pieces to iron. Only sheets, pillowcases, table linen, and underwear without buttons or ruffles should be put through a mangle. A mangle should be chosen with reference to the size of the articles to be ironed. If it is too small, folding articles many times makes progress slow, and the repeated ironing on the folds causes much wear. Mangles may be hand-driven or attached to a motor, and may be heated by gas, kerosene, gasoline, or electricity. A cold mangle, however, may give much service; it smooths only by pressure, giving no gloss nor glaze, and does not sterilize. (See fig. 7.)

CURTAIN STRETCHERS.

Curtain stretchers do not cost much and soon pay for themselves in saving the worker's time and wear and tear on the curtains. Also, most kinds of curtains hang better if stretched into shape rather than ironed. In buying curtain stretchers it is worth while to pay a little more for a good, rigid kind that can also be used for drying blankets. Blankets dried on a stretcher keep their shape.

The pins in a curtain stretcher may be movable so as to fit all the scallops in a curtain, but stationary pins are more satisfactory and substantial. Instead of having pins on the stretcher, many housewives wrap the frame with heavy ticking or tape and pin the curtains or blankets to these pieces. Some frames are tied together at the corners with strips of tape or muslin, but clamps cost very little and are much more convenient.

SUGGESTIVE LIST OF EQUIPMENT FOR A HOME LAUNDRY.

- Washing:
  - Boiler, copper bottom, 10 gallons.
  - Soap dish.
  - Washboard, glass or zinc.
  - Washtubs.
  - Wringer.
- Drying and sprinkling:
  - Clothesline.
  - Clothespins.
  - Clothes props.
  - Curtain stretchers.
  - Duster for line.
  - Sprinkler.
  - Whisk broom.
- Starching:
  - Pan or basin, enameled ware.
  - Saucepan, enameled ware
  - Strainer, tin.
- Ironing:
  - Asbestos mat (for protecting the ironing board).
  - Bosom board.
  - Clotheshorse.
  - Felt or silence cloth for ironing board or table.
  - Iron holders.
  - Ironing board.
  - Ironing table.
  - Iron rests.
- Ironing—Continued.
  - Irons.
  - Paper, for cleaning irons.
  - Sleeve board.
  - Wax for irons.
- Miscellaneous:
  - Bottles.
  - Bowls, enamel, 2 to 6 quarts.
  - Case knife.
  - Cheesecloth.
  - Cloth for cleaning tubs and boiler.
  - Clothes basket or clothes hamper.
  - Clothes stick.
  - Dipper, block tin, short handle.
  - Droppers.
  - Enamel cloth for table.
  - Flannel.
  - Floor mop.
  - Fruit jars.
  - Measuring cup.
  - Pail or bucket, galvanized iron, 10 quarts.
  - Pins.
  - Quart measure.
  - Scrubbing brush.
  - Spoons.
  - Tape measure.
  - Teakettle.

METHOD OF LAUNDERING.

While cotton, linen, wool, and silk are all laundered by washing and ironing, certain modifications of the process are made according to the nature of the fiber and whether it is colored or white. Washing displaces the dirt by forcing soap and water through the fabric. In doing this more or less friction may be used, the soap may or may not be rubbed directly on the fabric, and the process may be carried on with widely varying temperatures. Allowing clothes to get too soiled is more destructive to them than hard wear, because of the increased rubbing needed to clean them.

The family washing should be sorted into groups of white and colored clothing, with separate piles for wool, for silk, and for linen and cotton. Colored clothing, silks, and wools should be washed separately, for they can then be given special treatment. Torn places should be mended, and stains[1] should be removed before the garments are washed.

WHITE COTTONS AND LINENS.

Soaking.—Soaking clothes overnight or even for a shorter time loosens dirt, saves time, and lessens wear. Clothes may be soaked by covering them with cold or lukewarm water, or by wetting, soaping, rolling, and putting them into a small amount of water. The latter method takes more time but is more effective if there are no stains. Soaking for a short time in lukewarm water is as effective as longer soaking in cold water. Putting very dirty clothes to soak with cleaner ones may add greatly to the labor of washing the latter. Washing soda, ammonia, borax, or other chemicals are sometimes added to the water if the clothing is very dirty. This may be done simply to soften hard water (see p. 25) or as an extra help in loosening dirt when the water is already soft. In the latter case the chemicals are not likely to help unless soap is used with them.

It is safe practice to dissolve 1 pound of washing soda in a quart of water and mix 1 tablespoon of this solution in a gallon of soapy water. If the soda is mixed directly into the water used for soaking, there is danger that it may not be entirely dissolved and may eat holes in the clothes. The necessary amount of ammonia depends on its strength; about 3 tablespoons to the gallon is perhaps a safe allowance either for the dilute "household" ammonia bought at grocery stores or for the concentrated ammonia bought at the drug store and diluted at home to about eight times its original volume. From one to one and one-half teaspoons of borax to a gallon of water is the amount commonly suggested for soaking in soft, soapy water.

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[1] U. S. Dept. Agr., Farmers' Bul. 861 (1917), Removal of Stains from Clothing and Other Textiles. U. S. Thrift Leaflet No. 6 (1919), How to Remove Stains.

If the water is hard, soaking of any kind is unsatisfactory because of the scum that settles on the clothes. Soap will help to prevent scum from forming.

Washing.—After the clothes are soaked they should be put into fresh wash water as hot as the hands can bear, with soap enough to produce a lasting suds, and then the soapy water should be forced through the fabric. Whenever the water becomes dirty, it should be replaced by fresh suds. If the clothes are washed by hand, it is better to turn them during the process and wash from both sides. Special attention should be given to hems and other parts that are much soiled. If the clothes are washed in a machine, the very soiled parts may need to be rubbed with soap as the garments are put into the machine.

The rubbing on a washboard should be gentle. The aim is to force water through the fabric; therefore soiled places should not be rubbed when they are more or less dry, but should be kept wet by frequent dipping, after each rub, if possible. Using the fleshy part of the palm in rubbing saves the laundress from scrubbing the skin off her knuckles. A small brush will be a great help in washing such heavy garments as corsets and overalls. If the water is very hard it must be softened for use in washing (see p. 25).

Boiling.—Boiling helps in cleaning soiled clothes and in sterilizing them, but they should be well washed first. With good outdoor drying facilities, boiling may be omitted. Only white cottons and linens may be boiled. Clothes that are to be boiled should be wrung from the wash water, shaken, rubbed with soap, especially in soiled places, and put into the boiler with cold water, or cold water to which soap solution or soap chips have been added. In all cases plenty of water should be used, and each boilerful should be started with fresh cold water. Naphtha soap should not be used in boiling clothes. The water should be gradually heated and the clothes pressed down and stirred with a stick, which may be used to lift them into the rinsing water. Most clothes need only about five minutes of actual boiling; too long boiling should be avoided because it tends to yellow the cloth.

Kerosene, turpentine, or shaved paraffin may be added if the clothes are very dirty or yellowed. From 1 tablespoon to a half cup for a boiler of water may be used. If kerosene is used the clothes should be thoroughly rinsed in order to remove the odor, which is particularly difficult to remove if hard water is used. This is equally the case with turpentine, the odor of which is even more objectionable to many persons, so much so that it is sometimes believed to cause illness; it is also sometimes considered injurious to the hands. An easier but more expensive method of whitening clothes is to add the juice of one or two lemons to a boilerful. If clothes are not boiled, they may be scalded by covering with boiling water. It may be a good plan to boil every week the clothes that get very dirty, and the others only every three or four weeks.

Rinsing.—After boiling, or washing and boiling, clothes should be thoroughly rinsed in hot, clear water. This is more important than many housekeepers realize. If not thoroughly rinsed, the clothes may become grayish, or the soap left in them may act on the bluing to form rust spots, or the soap and the starch, if the latter is not pure, may yellow them. Moreover, traces of soap or washing soda may weaken the fiber of the material when heated in ironing. If the rinsing water must be softened, either borax or ammonia should be used; washing soda must not be used for this purpose because it is too strong a chemical to leave in the clothes.

Bleaching.—Clothes that are very yellow from long standing or from poor washing and drying may require bleaching. They may be soaked for several hours in water containing borax in the proportion of one-fourth cup to 1 gallon of water; if this is not effective the clothes should be wrung loosely and spread on the grass to dry in the sun, or in cold weather allowed to freeze. The clothes may need repeated wetting and several days out of doors. Javelle water also may be used to bleach cotton and linen clothes. It is prepared by dissolving 1 pound of washing soda in 1 quart of boiling water and adding ½ pound of chloride of lime dissolved in 2 quarts of cold water. This solution should be filtered, and the clear liquid stored in a tightly stoppered bottle. Fabrics to be bleached may be put in Javelle water diluted with hot water (½ pint of Javelle water to 1 gallon of hot water), and the liquid brought only to the boiling point. Then the garments should be removed and washed thoroughly in plenty of soap and water, or in ammonia water. Only cottons and linens may be bleached with Javelle water, as it dissolves wool, turns silk yellow, and weakens the fibers of cottons and linens if they are boiled in it.

Bluing.—New clothes and those washed in soft water and dried in the sun should not need bluing. There are so many kinds of bluing and various fabrics take them up so differently that definite directions for the amount to use can not be given. Table linens and open mesh fabrics, such as lace, readily take up blue. The strength may be tested by dipping a small garment into the bluing water or by holding a little of it in the hollow of the hand. In the latter test the blue color should be faint, but decided. The bluing water should be kept well stirred and, to prevent streaking, clothes should be shaken out before they are dipped and should not be allowed to lie in the bluing water. Table linen, bed linen, and other articles that are not to be starched are now ready for drying. For clothes that are to be starched the bluing may be added to the starch.

Clothes that have been overblued may be whitened by pouring boiling water over them, or if this is not effective, they may be boiled for a few moments. Continued overbluing of clothes may cause them to become gray.

Starching.—Clothes are starched to stiffen them, to give them the gloss of new material, and to make them keep clean longer. The following is a good general recipe for making cooked starch:

1 to 4 tablespoons starch, according to stiffness desired.
1 cup (½ pint) cold water.
½ teaspoon borax.
½ teaspoon paraffin or white fat.
1 quart boiling water.

Make a paste of the starch and the cold water; add the borax, the paraffin or fat, and the boiling water. Boil the mixture, stirring it thoroughly, until it is clear, or for about 20 minutes. Remove any scum that forms and strain the starch while hot.

The borax may be omitted, but it helps whiten the clothes and it, as well as the paraffin or the fat, makes the starch smoother in ironing. Alum is sometimes added (from 1 teaspoon to 1 tablespoon to 1 quart of water) and is useful in making the starch penetrate the fiber. It apparently thins the paste but does not decrease its stiffening property.

It is impossible to give definite directions for amounts of cooked starch to be used, because all depends upon the fabric and the degree of stiffness desired. However, if the 4 tablespoons of starch have been used to the quart of water, a cup of this may be diluted with about 3 quarts of water for starching such articles as petticoats and gingham dresses. Garments should be starched wrong side out and left so until they are sprinkled. For white clothes the starch should be as hot as the hands can stand, because it penetrates better, and thin enough not to leave a glazed surface when ironed. If many clothes are to be starched it is wise to keep a part of the cooked starch hot and add it to the used starch, as the latter becomes too cool and thin. The garments that are to be stiffest should be starched first. After thorough squeezing and dipping, the surplus starch should be wrung out and the garments either rubbed or patted. Garments wrung very dry before starching will be stiffer than wetter ones. Stiff-bosomed shirts should not be starched too far down nor pleated bosoms too stiff, else they will hunch up in wear, look clumsy, and feel uncomfortable. If one is starched too far down, the lower part may be moistened enough to render it pliable.

A solution of borax water (about 1 teaspoon of borax to 1 quart of water) may be used for stiffening very thin fabrics, such as laces, voiles, organdies, and dimities. It gives body and crispness, similar to the original dressing.

Hanging and drying.—Drying clothes out of doors in sun and air sweetens and bleaches them. If the clothesline is not taken down it should be wiped with a damp cloth before clothes are hung on it. Clothespins should be clean and are best carried in a bag or an apron made for the purpose. Placing the basket of clothes on a hand cart or an old baby carriage will save much stooping. It is sometimes possible to pin the clothes to a line on a porch or other protected place and then draw it across the yard by pulleys; this is a convenience, particularly when the ground is wet. Garments should be shaken, turned wrong side out if this has not been done before, hung on the straight of the goods, and fastened by the bands when possible. Large pieces, such as sheets, should have from a fourth to a half of the article placed over the line and should be pinned in four or five places; hanging by corners or edges increases the danger of tearing. Clothes that have been properly hung are much more easily ironed than those that have been stretched out of shape by careless hanging. Starched clothes should be brought indoors as soon as dry, because with long hanging they lose their stiffness. A high wind may tear clothes and, like any rubbing, will take the stiffness out of starched goods. If clothes are folded carefully as they are taken from the line the work of ironing is reduced and some articles, such as bed linen and towels, may be used without ironing or by ironing the hems only. In extremely cold weather the housewife should protect herself from the danger of going out of doors from a hot, steamy room by pulling on a warm sweater or a heavy wrap and loose, heavy gloves.

Sprinkling.—Clothes should be sprinkled evenly and thoroughly but should not be wet too much. Linen may be dampened more than cotton, but starched clothes will be sticky if too damp. After being sprinkled the clothes should be pulled into shape, turned right side out if necessary, and rolled tightly. Care in rolling will aid greatly in making them more easily ironed. The rolls should be placed close together in a basket, covered with a clean cloth to prevent the outside layers from drying, and left at least half an hour, but better, overnight, to allow the moisture to spread evenly. If clothes are left damp too long during warm weather there is danger of mildewing.

Ironing.—Clean, hot irons are essential to successful ironing. Rubbing the irons occasionally with wax or paraffin will help to keep them in good condition. An iron is hot enough to use when it "spats" if touched with a moistened finger. A worker who moves her iron rapidly can use a hotter iron with less danger of scorching than can a person who works more slowly. Slightly scorched places may be washed out or bleached out by wetting them and drying them in the sun. Too cool an iron may leave a rust stain, which may be washed out, but the fabric should be partly dried again before re-ironing. With starched clothes the iron must be hot enough to glaze the starch; otherwise the starch will stick and discolor the fabric.

All materials should be ironed with the thread of the goods and ironed dry. If materials are not ironed dry they will pucker later and look as though they had been rough-dried. Ironing as large a space as possible before shifting the garment saves time. In general, clothes should be ironed on the right side. Embroidery, however, should be ironed on the wrong side on a thick, soft pad, so that the design will stand out.

The general rule is to iron first those parts of the garment that will hang off the board while the rest is being ironed. For example, with a man's shirt or a shirtwaist, iron the cuffs and sleeves first, then the collar, and then, beginning with one side of the back or the front (depending on where the garment fastens), continue around to the other side. Every good laundress, after ironing a garment, looks it over carefully and presses any part that has become rumpled in handling; but if ironed dry, it should rarely need much re-pressing. If a gloss appears on hems or tucks or on heavy linens, it may be removed by moistening a piece of cheesecloth with clear water, wringing it very dry, and wiping quickly over the glazed surface. Too high a gloss on shirt bosoms, collars, or cuffs may be removed in the same way.

The amount of ironing needed may be very much lessened by choosing clothing and household linens with this in mind. Knitted underwear and garments made of crêpe and seersucker may often be carefully pulled into shape instead of ironed. Shirts with plain soft bosoms and soft cuffs are easier to iron than those with stiff or pleated bosoms and stiff cuffs. Underwear, blouses, and wash dresses with simple flat trimmings are more easily ironed than elaborate ones. Small plate doilies are easier to launder than large tablecloths. Carefully stretched towels can often be used instead of ironed ones, and many housekeepers prefer the freshness of unironed sheets to the polish of ironed ones. Special care must be taken in hanging out articles to be used unironed so that they may dry in as good shape as possible.

Folding and airing.—Clothes should be folded with the thread of the goods and hung until thoroughly dry in a place free from odors. In many households the ironed and folded clothes are put to air on a clotheshorse, which is closed and set out of the way when not in use. If, as they are folded, articles that need mending are sorted out, time and labor will be saved.

SILKS AND WOOLS.

Silks and wools are animal fibers and when moist are extremely sensitive to intense heat and to all rubbing; moreover, they harden, yellow, and shrink from the effect of strong alkali. They should not be soaked and should be washed in lukewarm water (about

110° F.) with a neutral, white soap, dissolved in the water and not rubbed directly on the material. Silk is not so easily affected by strong alkali as is wool, but its gloss is destroyed. The garments should be "soused" up and down and squeezed, but not rubbed, pulled, nor twisted. Very soiled places, such as cuffs and collars, may be cleaned by rubbing in a good suds with the palm of the hand.

Silks and wools should be rinsed as many times as necessary in water of the same temperature as the wash water. There is no advantage in adding soap to the rinse water, as is sometimes suggested. White wools and silks may be blued, but the bluing water should be of the same temperature as all the other water used. Woolen and silk garments may be wrung through a loosely set wringer, or the water may be squeezed out, but the material must not be wrung by twisting. Silk may be wrapped in a towel or heavy cloth before wringing.

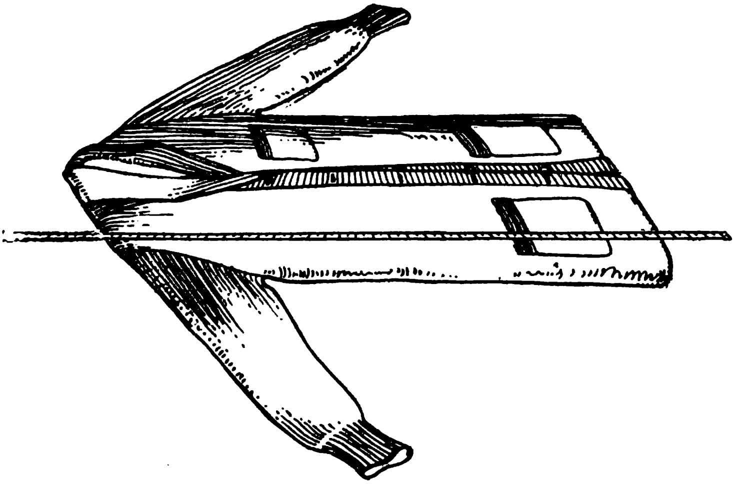

FIG. 8.—Washed sweater, shaped to original dimensions and spread out to dry.

Gum arabic is of special use in redressing silks. If in powdered form, one or two teaspoons of gum arabic should be allowed to stand in a quart of warm water until dissolved, and then this solution should be strained for use. If the gum is in lump form, boiling water should be used and the mixture kept hot until the gum dissolves; a double boiler may conveniently be used for the purpose. A quarter of a cup of this solution to a quart of water gives an average stiffness.

Wool will shrink if dried in too hot a place. Neither silks nor wools should be allowed to freeze, and they sunburn if put wet in the sun. Silks of fast dyes should be rolled while wet in heavy cloth until they are right for ironing, and not hung up to dry.

The irons used on silks and wools should be medium hot, as both these fabrics scorch easily and little can be done to remove the discoloration. Silks and wools should be covered with a cloth if they are ironed on the right side, or they may be ironed directly on the wrong side. Wools iron more easily while still damp, for any creases are hard to press out if allowed to dry in. Silks should be rolled and ironed while still damp; parts that dry out should be ironed through a dampened cloth, for sprinkling is likely to spot silks. A well-ironed silk should be soft, not crisp and papery. Knitted and crocheted garments should be measured before they are washed, carefully pulled or patted into the original shape (see fig. 8), while still wet, and placed on a padded table to dry.

COLORED FABRICS.

Manufacturers endeavor to set the color of the dyes in their fabrics, but are not always able to permanently fix them. Special treatment before washing will sometimes help. Various chemicals may be used, but some of them are poisonous and for that reason undesirable. Housekeepers think common salt is effective for setting most dyes. No special rule can be given as to the amount of salt to use; about 1 cup of salt to 2 gallons of water is a good proportion to try, and more salt may be added until the color stops "bleeding." The color is more likely to be set if the material can be left in the salt water overnight rather than for a shorter time, and if it can be dried before washing. Sometimes salt is put in the final rinsing water in laundering colored goods. Setting color with salt is not likely to have a permanent effect, and the process may need to be repeated whenever the garment is laundered; also soap is less effective in water to which salt has been added.

Colored clothes should be washed in lukewarm water and neutral soap solution, and the fabric should be squeezed rather than rubbed. Unless the color is fast, no colored clothes should be soaked for any length of time, nor should they be boiled or exposed to too high a temperature in washing, rinsing, starching, or ironing. If the color seems very delicate, very cool water should be used, and soapbark, bran, or cooked starch water instead of soap. With a color likely to fade or run, rapid washing is safest; the material should be wrung as dry as possible and rolled in a cloth to absorb extra moisture; an even safer way is to shake the garment dry. For dark colors it is well to tint the starch; for example, tea may be used for blacks, browns, and greens, and bluing for blues, and the specially prepared "mourning" starch for blacks. Colored clothes should be dried in the shade and should not be allowed to freeze. They should be ironed on the wrong side.

INFECTED CLOTHES.

Clothing and linen used by a person suffering with any contagious disease and handkerchiefs used during a cold, need special treatment and should not be kept or washed with other clothes. Separate bags or other containers that can be sterilized or destroyed should be provided. Infected clothing may spread the disease directly to the persons who handle it or indirectly through contact with other articles. Boiling is the simplest method of sterilizing infected clothing, but the heat is likely to injure some fibers and set stains and dirt; therefore other methods are sometimes preferable. The United States Public Health Service gives the following directions for handling infected clothing:

> Clothes worn by a person suffering from or exposed to a contagious disease, or bed linen, may be disinfected previous to washing by immersion in one of the following solutions for one hour:
>
> A 5 per cent dilution of the commercial solution of formaldehyde (formalin).
>
> A 1 per cent solution of phenol (pure carbolic acid).
>
> A ½ per cent solution of liquor cresolis compositus.
>
> Infected clothing may also be readily sterilized by immersing in boiling water for 10 minutes.
>
> Woolen goods may be disinfected by immersing in water maintained at a temperature of 165° F. for 20 minutes. If the goods are then carefully washed and dried, no undue shrinkage of the garments should result and the infectious agents of disease, except those due to spore-forming bacteria, such as anthrax or gas gangrene, will have been destroyed.
>
> Soaking in the solution recommended on page 15, prior to the disinfecting process, may prove advantageous in removing dirt and stains. These cleaning solutions may be readily sterilized after use by boiling them in the containers in which they were used.
>
> The person who handles the infected garments should wear some form of apron to protect the clothing, and this apron should be disinfected immediately after the soiled clothes are handled. Also the hands and forearms should be thoroughly scrubbed with soap, water, and a nail brush for 10 minutes by the clock, and thoroughly rinsed in either the phenol solution or the cresolis solution mentioned above or in a 1:1000 solution of bichlorid of mercury.
>
> These precautions are necessary in order to prevent the germs on the clothes being carried to the mouth of one handling the clothes or indirectly to the mouths of others.

SPECIAL CLEANING AND PRESSING.

To sponge and press cottons, linens, and silks.—To press out wrinkles from these fabrics they should be ironed through a piece of thin cotton material wrung out of clear water, or a part of the garment should be sponged with even strokes and then ironed dry. Heavy or colored goods should be sponged and ironed on the wrong side. Sponging with thin starch or gum-arabic water will make some fabrics seem almost new. Success lies in having the garment evenly dampened so that no water rings are formed nor an uneven stiffness produced.

To sponge and press woolens.—With woolens a thicker cloth must be used for dampening, to provide enough moisture. Plaits or folds may be basted in place, but the stitches should be drawn as soon as the cloth is steamed; otherwise the thread will mark the material. Heavy irons are more satisfactory on materials such as are used in men's suits.

The appearance of woolen materials that have worn shiny may be improved by covering the right side of the material with a cloth wrung out of ammonia water (4 or 5 drops of ammonia to 1 quart of water), pressing with a medium-hot iron until the cloth is partly dry, and then brushing the wool vigorously with a stiff brush.

In silk and wool, wrinkles such as are caused by packing may be removed by hanging the garment either out of doors on a damp day, or in a steamy room.

To freshen velvets.—Most velvets may be freshened by steaming from the wrong side. One way is to draw the velvet through the steam from a teakettle. Care must be taken that the teakettle contains only a little water, or the water may spatter out and spot the velvet. As a special precaution several thicknesses of cheesecloth may be tied over the spout. A cone of heavy paper placed around the spout will direct the steam and make it possible to hold the velvet farther from the heat. Another way to steam velvet is to place several thicknesses of damp cloth over a hot iron and pass the back of the velvet quickly over the cloth. Velvet so creased that it can not be freshened by steaming may be "panned" by steaming and ironing it in one direction.

Dry cleaning.—Clothes may be dry cleaned with absorbents, such as starch, fuller's earth, and French chalk, or with such liquid solvents as gasoline, benzine, and carbon tetrachlorid. The last mentioned is not inflammable and does not form an explosive vapor like gasoline and benzine. It is sold under special trade names or may be purchased as such at many drug stores. All of these cleaners remove the grease that holds the dirt in the fabric; the powder absorbs it, the liquids cut it.

To clean with absorbents, cover the material with the powder, let stand for several hours, and remove the powder by shaking and brushing. The process may need to be repeated, and warming the powders sometimes makes them more effective. This method of cleaning is especially useful on laces, white wools and furs, and coat collars and cuffs.

Most liquids (except carbon tetrachlorid) used in dry cleaning are highly inflammable; therefore they must be used out of doors in the shade, away from fire, and friction must be avoided. The fire laws in some places allow so little gasoline to be used in the household that one can not employ it for general cleaning purposes. Mixtures of carbon tetrachlorid and gasoline are much less inflammable than gasoline alone and are said to be equally effective.

To clean a garment with gasoline, or other liquid solvent, cover it with the liquid, squeeze rather than rub it, and rinse it once or twice.

Thorough rinsing is just as necessary with a garment cleaned in this way as with one washed in water. For very soiled garments white soap may be used with gasoline, as with water. As pure a grade of gasoline as possible should be obtained, and even then it is wise to strain it through a cloth to remove sediment

GENERAL LAUNDRY SUPPLIES.

WATER.

A convenient water supply is a matter of course in most town and city homes, and to have one installed in every village and farm home is an ideal which ought not to be impossible of realization.

A simple, inexpensive way of connecting the pump in the yard with a faucet by the kitchen sink is described in other bulletins of this series.[1] When there is no special plumbing for the washtubs, much hard work is saved by running a piece of hose from the nearest faucet to the tubs. If the water must be carried by hand, more trips with smaller buckets are usually considered less tiring than fewer ones with heavier pails. Sometimes a child's cart can be used to advantage.

Water may be soft or temporarily or permanently hard. For laundry work the softer the water the more desirable it is, not only because it is a better solvent but also because it more readily forms a suds with soap. Soap may be used to soften hard water, but is precipitated in the form of an insoluble scum, which, if allowed to settle on the clothes, is very difficult to wash out. Temporarily hard water may be somewhat softened by exposure to the air, because then the soluble carbonates change to an insoluble form and settle. If this method is to be used, available containers—washtubs, boilers, and pails—are filled with water and allowed to stand overnight. However, this is usually impracticable and involves much lifting of water. Softening temporarily hard water by boiling is a better method but is also laborious. If steam heat is used in a house, an appliance may be installed for condensing the steam and so obtaining distilled water from either permanently or temporarily hard water.

The most practical measure, under ordinary circumstances, is to use chemicals to soften water, for neither boiling nor exposure has any effect on permanently hard water. Washing soda is the chemical perhaps most commonly used for this purpose, since it is inexpensive and effective. One pound of soda should be completely dissolved in a quart of water and two tablespoons of this solution used for each gallon of moderately hard water. In certain regions, for example, in irrigated sections where the water is alkaline, better results are obtained if the wash water containing this solution is boiled and the scum strained off before the clothes are put in. Clothes should never be put into water in which there is undissolved soda, for the latter may make holes in them.

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[1] U. S. Dept. Agr., Farmers' Bul. 927 (1918), Farm Home Conveniences, pp. 23–29, and Farmers' Bul. 941 (1918), Water Systems for Farm Homes.

Instead of washing soda, lye may be used, but has no special advantage over soda and is so much stronger that it must be used with great care. Two teaspoons of lye, dissolved in water, are used for 1 gallon of moderately hard water. If the water is very hard, more soda or lye must be used, but if too much is added it may injure the clothes. Borax and ammonia are more expensive agents for softening water. Borax is only mildly alkaline, but in addition to softening the water it tends to whiten the clothes. It may be used with colored clothes and woolens, when neither washing soda nor lye should be used, and in rinsing water. Ammonia is volatile and evaporates readily, and is likely to be less effective in long soaking or boiling processes, but, like borax, may be used in rinsing water. It is usually cheaper to buy strong ammonia at the drug store and dilute it with water than to buy household ammonia (see p. 15).

Besides having the water soft, it must be clean. If the water is muddy, straining through heavy material will help to clear it. For this a salt bag may be tied over the spout of the pump or the mouth of the faucet.

If the water contains iron, as is often the case, it is a great handicap in laundry work. Sometimes iron is present in such form that it will "settle out" on standing. Sometimes only the water that is first drawn is rusty, but later will become clear. If the iron is really in permanent solution, it is sometimes possible to use such water by washing quickly and not allowing the clothes to stay in it. A safer method is to precipitate the iron by adding washing soda and letting the water stand for several days; then the clear water should be carefully poured off, leaving the sediment in the bottom of the vessel.

SOAPS.

Laundry soap may be either yellow or white, the yellow color generally being due to the presence of rosin. A little of this helps in producing suds, but an excess, such as is likely to be found in very dark brown soaps, is objectionable because it serves no useful purpose in laundering and because it forms a sticky scum which may adhere to the clothes. Much rosin can be easily detected, for it gives the soap a pungent odor and a sticky quality.

Soaps may be classed as strong, medium, and mild. Strong soaps contain an excess of soda or lye, and while they will not harm white cottons and linens, they can not be used safely with silk, wool, or colored fabrics. Any one can tell whether soap contains an excess of soda or lye by the following simple tests: Such soap causes the hands to shrivel into the condition so long known as washerwoman's hands, and has a biting taste when touched with the end of the tongue. Medium soaps usually contain some free soda or lye.

A mild soap contains no free soda nor free lye and is the best for general purposes if only one kind is used in the laundry. If a stronger effect is desired, washing soda may be added to the water instead of using a stronger soap, which contains it in unknown amount. If soda is used, clothes must not be boiled with it, for heat intensifies its action. Even a dilute solution may shrink and discolor wool, may fade colored fabrics, and will yellow white silk.

If the supply of hot water is limited, naphtha soap may be used to good advantage with cold or lukewarm water. Naphtha helps loosen the dirt in the clothes but is too volatile to be effective with hot water.

It is not economy to use a poorly-made soap which may contain free grease or an excess of lye, or both. This is sometimes the case with homemade soaps, but need not be so if good directions (for example, those that come with the commercial lye in tin cans) are carefully followed. Making soap at home may not be good economy where the fat can be sold for use in a soap factory, but it is a thrifty practice where the fat would otherwise be thrown away.

Boiler or chip soap is more economical than cake soap for use in the washing machine, but does not take the place of cake soap when clothes are washed on a board. Almost all soap manufacturers make a chip soap which may be bought by the pound at the grocer's or obtained by parcel post or by freight from the factory. Soap chips can be made at home by shaving up a cake of soap or putting it through a food chopper. One pound of chips dissolved in five gallons of water makes a good strong soap jelly, which should be added to the water in the boiler or washing machine in sufficient amounts to make good suds. A more economical solution to be used for white cottons and linens may be made from one-half pound of soap chips and one-fourth pound of soda to five gallons of water; this must not be used for wool, silk, and colored fabrics. Soap solution will keep indefinitely if covered to prevent evaporation.

Dye soaps.—These are supposed to clean and dye at the same time. It is safer, however, before using the dye soap, to wash the garment clean with white soap and water. The best results come from dipping the garment in a generous quantity of water to which the tint has been added. The color is always fainter after drying than while the garment is wet. The tinting is usually not permanent and the process should be repeated with each laundering.

WASHING POWDERS.

Most washing powders are a mixture of soap and washing soda, although some contain even stronger chemicals. This will explain why clothes fade, why silks turn yellow, and why woolens "harden" when too much washing powder is used. Washing powder and washing soda are sometimes used for washing babies' diapers because they make it easier to remove stains, but they must be cautiously used and *very thoroughly* rinsed out with hot water, or they are very likely to irritate the skin. A little commercial formaldehyde such as is sold by druggists (about a teaspoon to a quart of water) may safely be used in the water for soaking as a deodorant before washing such offensively soiled articles. As the formaldehyde irritates the skin, the clothes should be lifted with a stick and thoroughly rinsed in clear water.

SOAP SUBSTITUTES.

When the action of soap is likely to injure a delicate color, soapbark, starch water, or bran water may be used instead.

Soapbark, although not a soap, when heated in water will form suds. To prepare it for use, boil for 10 minutes a cup of the bark with one quart of water, and cool and strain the liquid. The "soapy" water may be used full strength for sponging or diluted for washing; half of this amount is enough for one-half tubful of water. Since the liquid is brownish, it should be used only on dark-colored goods.

Starch water is especially good for cleaning delicate cotton fabrics. This is usually made by adding thin starch paste to the wash water. Water in which rice has been boiled, if it is not discolored, may be used instead. If it is not desirable to have the material starched slightly, it must be rinsed in salt water.

Bran water, made in the same way as soapbark solution, is useful with colors that are likely to fade. It does not give suds, but cleans like starch water.

BLUINGS.

Bluings differ in composition as well as in form. The commonest bluings are Prussian blue, aniline, and ultramarine. Indigo is now rarely used. Bluing in solution colors fabrics more evenly than bluing that is merely in suspension. "Bottle blues" are in many cases made of Prussian blue, an inexpensive soluble salt of iron. Unfortunately, however, they are easily decomposed by soap, and if the clothes are not thoroughly rinsed, iron-rust stains may appear on them when ironed. It is easy to discover whether or not a bluing contains iron, by adding strong soapsuds to some of it; if it changes from blue to yellow, iron is present.

Aniline blues are also soluble and may be bought in both liquid and powdered form. Although the powder seems dear when it is bought by the ounce, so little is used at one time that it is really not expensive and is, perhaps, to be preferred to any other kind of bluing. A quarter of an ounce may be dissolved in a quart of water, bottled, and kept indefinitely; a half tespoon of this is enough for a tub of water.

Ultramarine blue is not very soluble and is sold in balls or cubes. Because it is difficult to dissolve, more of it must be used to be effective and the water must be kept well stirred to prevent the bluing from spotting or streaking the clothes. For use, the balls or cubes, wrapped in heavy muslin or flannel so that only the very finest particles of the ultramarine may pass through, should be soaked in a bowl of water and this liquid added to water for bluing.

STARCHES.

A good starch is one that penetrates the fiber and stiffens a garment without making it look glazed or as if it had been pasted with starch. Cornstarch, wheat starch, or water from cooking rice, tapioca, or other starchy materials may be used, but for laundry work in this country cornstarch has been the most common. Commercial houses that supply the laundry trade sell blended starches, which probably give the best results of all.

Most housewives will find one kind of starch sufficient unless special effects are desired. Cornstarch is particularly good for collars, cuffs, and shirt bosoms; wheat starch for body clothes, and rice starch for lingerie and children's clothes. Blended starch made with two-thirds corn and one-third wheat starch is good for collars, cuffs, and shirt bosoms; and that made with one-third corn and two-thirds wheat starch for clothes to be less stiffly starched.

Prepared starches are sold for use in cold starching. The directions on the package should be followed. These starches are commonly used without cooking, and the garment is ironed while it is still damp without previous drying and sprinkling. The texture and color produced by this method are sometimes not so good as those obtained by the use of cooked starch.

SUPPLIES FOR A HOME LAUNDRY, INCLUDING MATERIALS FOR REMOVING STAINS.

Alcohol, denatured.
Alum.
Ammonia.
Beeswax.
Bluing.
Borax.
Chloride of lime.
French chalk or fuller's earth.
Gum arabic.
Hydrochloric acid.
Javelle water.
Paraffin.
Potassium permanganate.
Oxalic acid.
Salt.
Soap.
Soap bark.
Starch.
Tea.
Washing soda.

COMMUNITY LAUNDRIES.

For 50 years or more various foreign cities have been building washhouses along the rivers. Each house is equipped with standing troughs and usually a stove. For a few pennies the women can take their clothes there, wash them in the running stream, and dry them in yards on the banks. American cities have not imitated this type of washhouse, but in a few of the large cities special indoor washhouses have been built, many times in conjunction with municipal bathhouses. These washhouses are divided into compartments where a housewife may take her clothes and have the use of two washtubs and a wringer with hot and cold water. She takes her clothes home in the "wet wash" stage, ready to finish, or may dry them in the drying room.

In one or two cities municipal laundries have been established, to which women may carry their clothes, leave them, and have them washed with power equipment. Thirty pounds of clothes are allowed to one family for a given price, and, without marking or sorting, the bundle is put into a compartment of a washing machine large enough to hold eight such bundles at a time. Such a laundry is expected to be self-supporting but to make no money.

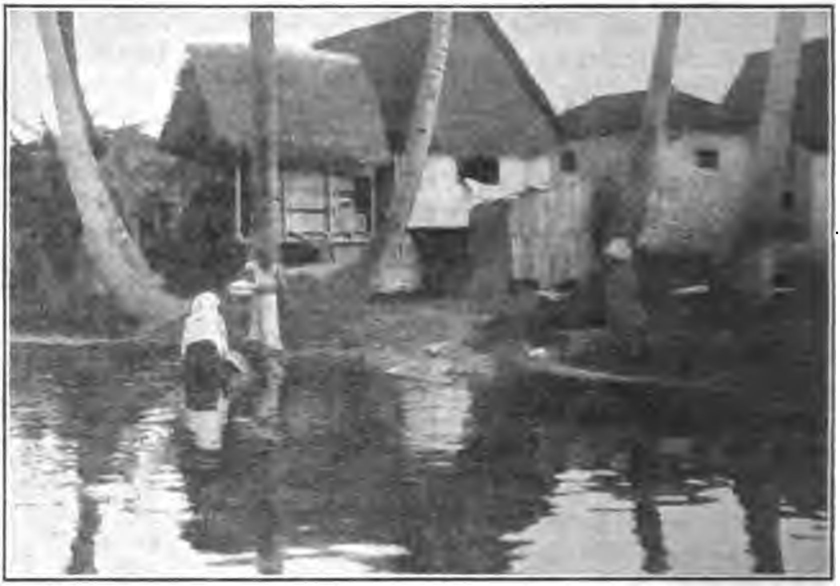

FIG. 9.—Primitive laundry methods in Guam.

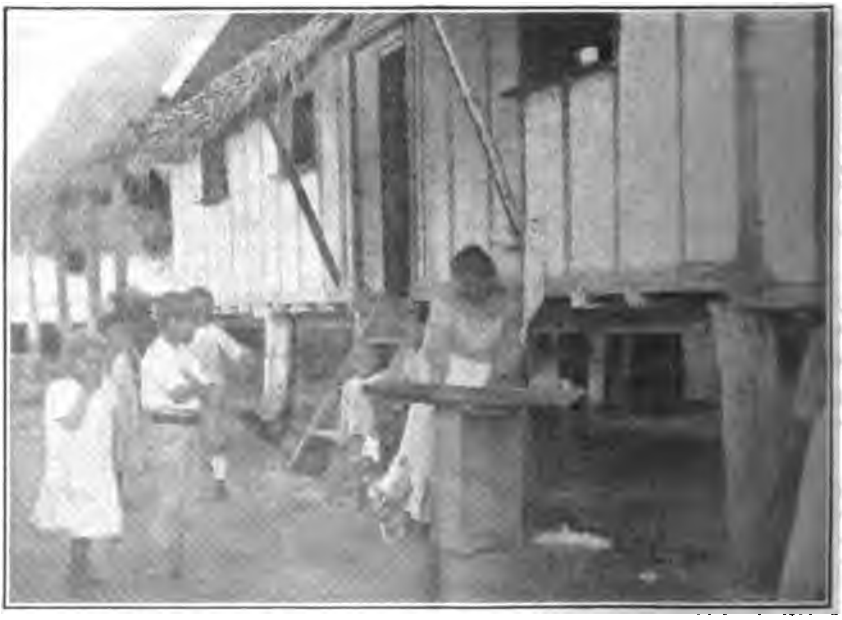

FIG. 10.—A Guam washing machine.

For some time a few cooperative laundries have been working successfully in certain rural regions, and county home demonstration agents report an increasing interest in such enterprises. One of the earliest was the outgrowth of a cooperative dairy (see figs. 11 and 12). The dairy building was enlarged and the same power plant now operates, with little extra expense, both dairy and laundry. The farmers who bring in milk receive tickets in return, which may be either turned into cash or used to pay for laundry work. In another case, a group of persons interested in a cooperative laundry bought the necessary equipment and arranged with a local creamery to furnish space and power; in another, certain members of a community united to build, equip, and manage a special laundry, which is successfully run on a cooperative basis. It is not necessary, however, to begin

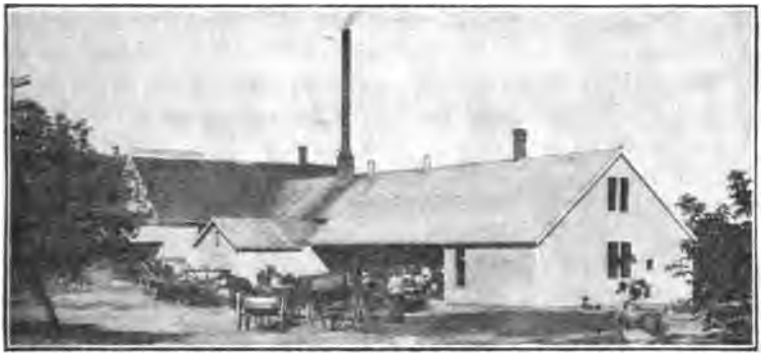

FIG. 11.—A cooperative community laundry in Minnesota.

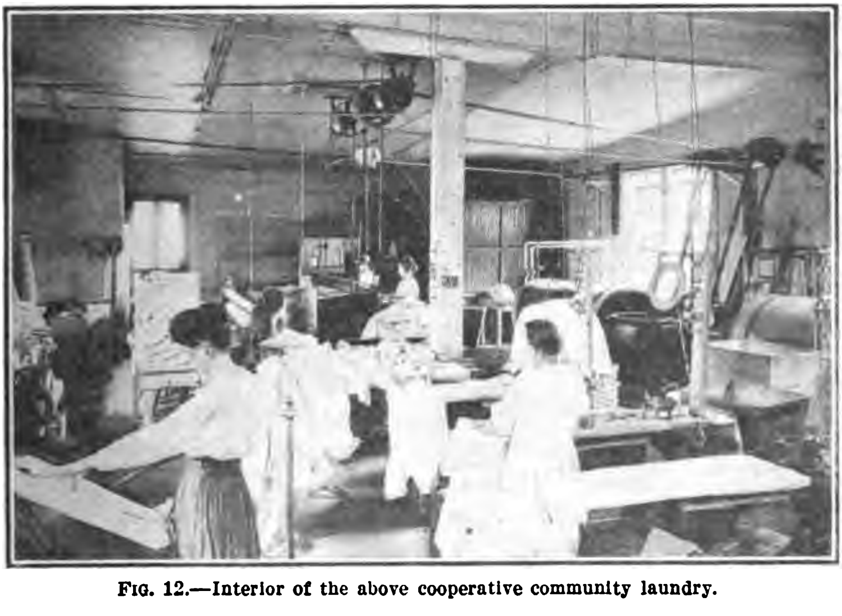

FIG. 12.—Interior of the above cooperative community laundry.

with so complete an outfit and organization. A successful community laundry can be started in a barn or shed by a few families, all sharing in the cost of simple machinery and either taking turns in using it or hiring the help necessary to run it. Before such an undertaking is started in any community a committee of those interested should find out how many families would use the laundry, what type of work they would wish (completely finished, rough-dried, partly finished and partly rough-dried, or delivered wet), what funds and buildings are available for starting the enterprise, and what type of equipment and service it is wisest to install. They should also realize that no such cooperative enterprise succeeds unless there is competent business management and unless members or patrons stand by it loyally through the trying per which is almost sure to come some time during the first few years. considering such an enterprise it is well to consult the ext director at the State college of agriculture or the county ag

COMMERCIAL LAUNDRIES.

Clothes handled in large quantities and by large machin necessarily subjected to greater wear. However, under some stances, this should not outweigh the time and strength to do the work at home. Most laundries will allow the hou to see the conditions under which the work is done. She cooperate with the laundry by having her bundles ready for collections instead of demanding the rush service that often in poor work as well as in overtime for the employees.

Commercial laundries give three types of service—" fini "rough dry," and "wet wash" work.

Usually all clothing is washed by machinery; as a rule, special laundries accept pieces to be washed by hand. In laundries all the ironing also is done by machines especially structed for the garments which they are to iron. This, of makes the work much cheaper. Usually the "flat work machine-ironed, and if the quantity warrants, this is rated dozen at lower cost than for clothes that are priced by the Most so-called "hand" laundries send out the washing to be power machinery and merely do the ironing themselves.

Sending clothes to "rough-dry" laundries means that all of washing is taken out of the house, since the clothes are after drying. Commercial laundries can do the washing cost, but the clothes are likely to be wrinkled and in poor ironing.

"Wet-wash" work is still cheaper because the clothes are but have as much water as possible extracted by wringing in trifugal machine. When returned they must be dried before

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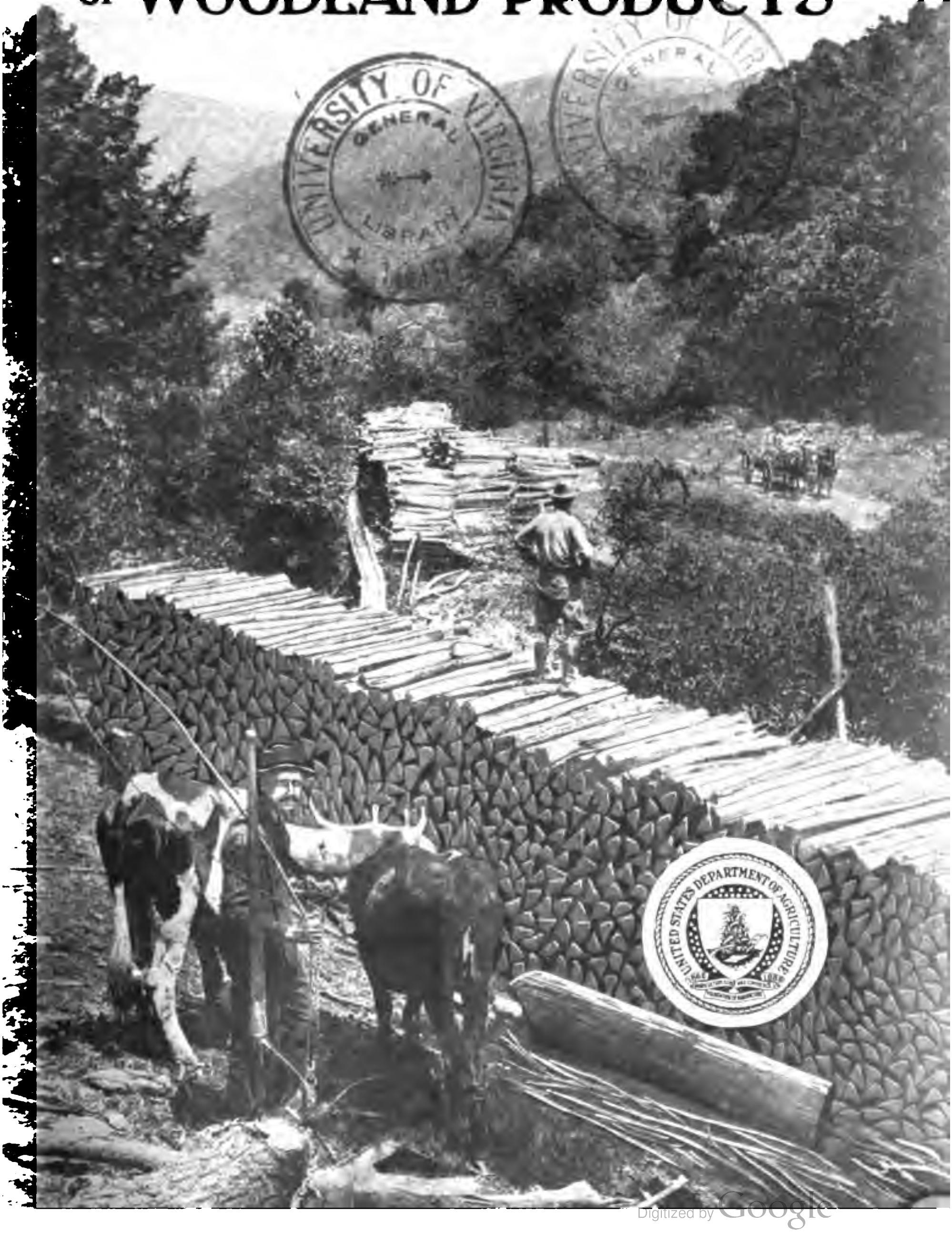
Farmers' Bulletin 1100
United States Department of Agriculture

COOPERATIVE MARKETING OF WOODLAND PRODUCTS



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FARMERS' COOPERATIVE ORGANIZATIONS for the marketing of farm produce have increased in number very rapidly in recent years. Certain kinds of produce are now very commonly marketed through associations. Woodland products also may be marketed in this manner. In fact some cooperative shingle mills are already in operation, and box factories maintained for the supplying of boxes to fruit growers at cost might be considered cooperative enterprises.

Much more might be done in this line, and this bulletin points out that what has been done in the cooperative marketing of other farm products can be done with woodland products also, with benefit both to the farmer and to the woodlands.

Contribution from the Forest Service
HENRY S. GRAVES, Forester
Washington, D. C. - - March, 1920

COOPERATIVE MARKETING OF WOODLAND PRODUCTS.

A. F. Hawes,
Extension Specialist in Forestry.

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MUCH PROGRESS has been made during the last few years in the cooperative marketing of farm produce, such as dairy products, fruit, potatoes, and live stock. That so little progress has been made in the cooperative marketing of forest products should not lead to the inference that such an arrangement is not as practicable for these products as for other kinds of farm output. It was natural that farmers should unite first to sell the crops and other products upon which they rely for their regular income. Woodland products they have always considered secondary; they have felt that anything obtained from the woods was in the nature of an extra dividend, and have been satisfied even if it was not as large as it should have been. Obviously, this is an unwise attitude to take. As timber products become scarce and increase in value, farmers will desire to make their woodlands a regular income-producing part of the farm, and will study the best methods of marketing. The purpose of this bulletin is to point out briefly what has been done in the cooperative marketing of other farm produce and to suggest an organization and methods adapted to the marketing of woodland products.

A survey undertaken by the Bureau of Markets in 1914 showed that there were approximately 12,500 farmers' purchasing and marketing organizations in the country. Of the 5,424 organizations which reported, 1,637 were grain elevators and warehouses; 1,708 were creameries and cheese factories; 275 were stores; 871 handled fruit and produce; 213 cotton; 43 tobacco; 96 live stock, and 581 were miscellaneous associations.

NEED OF FOREST PRODUCTS ASSOCIATIONS.

It is noticeable that forest products are not mentioned in the list of associations secured by the Bureau of Markets. There are, however, in the Middle West,[1] "farmers' cooperative companies," classed in the list as "stores," which buy lumber either as a sole product or with other products. Their object is to secure lower prices for the merchandise the farmer consumes. Approximately 10 per cent of the farmers' companies in the Middle West handle lumber. The number of these companies retailing lumber in 1915 was five times as great as in 1910. As a rule, the benefits of the low prices at which they sell are shared by the community, since few of them restrict their sales to their own members.

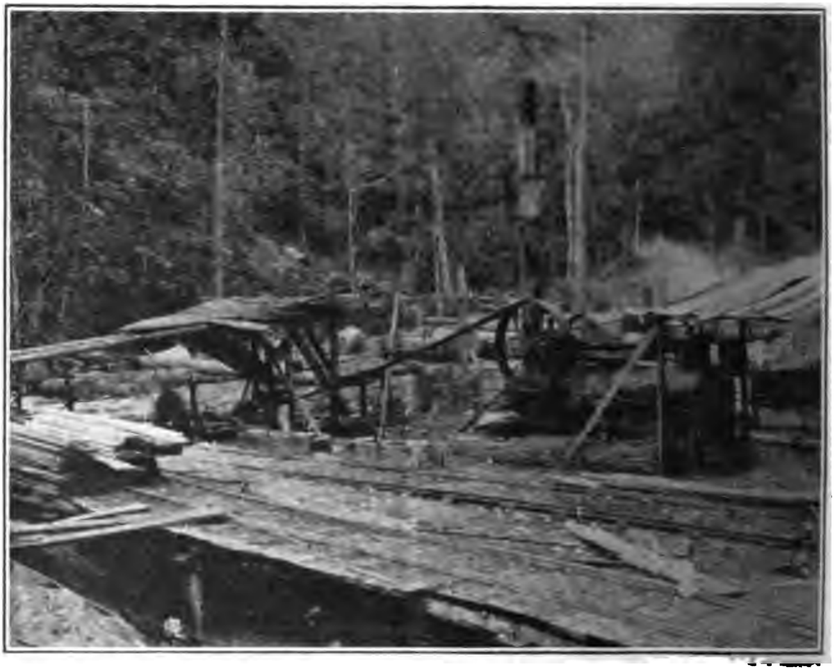

FIG. 1.—The portable sawmill operated by a cooperative association may be an effective agency for the proper development of a forest.

The efficiency of these buying organizations may very well indicate to the farmer in the wooded regions the advantage of the selling organizations advocated in this bulletin. There are few products of the soil the marketing of which would be more aided by the formation of cooperative marketing associations than forest products. Two considerations are of fundamental importance: (1) As ordinarily handled, the yield is not an annual one and the woodland owner is not in touch with the market. (2) Because of their bulk and weight, the transportation of logs is expensive and, therefore, the market is restricted geographically.

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[1] Report No. 116, Office of the Secretary, 1918, "The Distribution of Softwood Lumber in the Middle West," by Ovid M. Butler.

The small woodland owner is not in a position to study the market for his finished product, because the quantity is not sufficient to justify the necessary expense. He has resorted, therefore, to the easiest though least profitable ways of disposing of his forest products. These methods may be summarized as follows:

FIG. 2.—The proper handling of the forest requires the disposal of inferior trees, which can only be done profitably by the development of a special market.

(1) Sale of the woodland or farm to a millman for a lump sum.
(2) Sale of standing timber for a lump sum.
(3) Sale of standing trees or stumpage by a unit of measure, as thousand feet, cords, etc.
(4) Sale of logs by the thousand feet, delivered at a mill.

It is obvious that a millman who is in the business of buying timber can estimate the contents of a stand much more accurately than the ordinary owner can, and that he will usually have the advantage in any such transaction. Instances are numerous of timber sold in lump bringing less than half the stumpage value; and in many cases the discrepancy has been even greater. The sale of standing trees by the thousand feet is a satisfactory method for a distant owner, or for one not equipped for handling the operations of cutting and hauling. In the case of most farmers who are woodland owners, however, these operations furnish desirable employment for men and teams when farm work is slack. For such owners the sale of stumpage is not desirable.

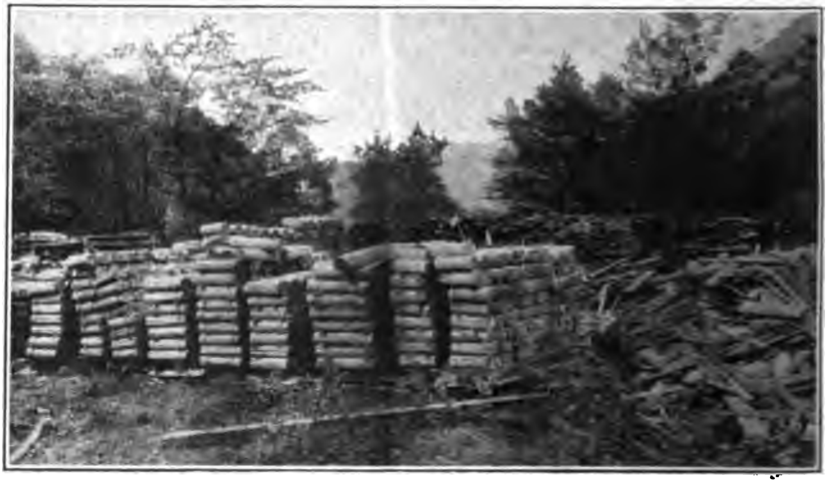

FIG. 3.—Stockyard, showing the finished product, ready for shipment, made from mill waste. Mop handles, chair legs, and chair dowels. Beech, birch, and maple.

For the average woodland owner it is more profitable either to sell the logs delivered at a mill or to employ a mill and sell the product. The difficulties in the way of such a woodland owner being both a successful operator and millman are: (1) He knows very little about the market requirements, has no sales agent, and does not know where there is the best demand for his products. (2) He knows nothing about lumber grades, and can not grade the lumber. (3) He usually does not have enough of the various grades to make up carload lots.

THE WORK OF A COOPERATIVE FOREST PRODUCTS ASSOCIATION.

The kind of forest products to be marketed will necessarily vary in different sections. In the majority of cases, however, lumber will form the chief product. Hence, forest products associations should employ a competent manager who is well acquainted with the lumber business and able to grade lumber. His first duty would be, in cooperation with the various woodland owners of the association, to make a careful survey of the timber controlled by the association. This survey should include an estimate of the various species, and, so far as possible, of the different grades present. It should also take into consideration not only the main products, but those by-products that might accrue, as, for example, hemlock bark, charcoal, etc. The marketing situation should be carefully studied to determine whether the existing plants are sufficient to give the most profitable utilization, or whether additional equipment—machinery, auto trucks, railroad sidings, etc.—are needed to give the best facilities. At certain seasons the manager should visit the near-by cities and wood-using industries and take orders in advance for the various classes of lumber which his association can produce. Information thus secured would be placed at the disposal of all members, and the amounts of lumber required would be allotted among them. At the time of sawing the manager would take charge of the grading. It would be necessary to keep a careful record of the amount of each grade of lumber furnished by the various members.

Fig. 4.—Shingle mill, showing engine, shingle saw, etc.

By combining forces in this way, an association would be able either to operate its own sawmill or to secure a lower rate on custom sawing. The advantage which the millman ordinarily has of being able to dispose of his various grades in car lots would accrue to the association. Such an association would also be in a position to secure the best freight rates possible, to utilize better advertising media than are usually available to the small woodland owner, and to make use of better business methods than he can afford.

The value of logs delivered at the mill and the grade of logs that can be sold at a profit depend on the character of the mill and the form in which the lumber is to be sold. The small mill that can manufacture only rough lumber, and this in such small quantities that it must be sold without grading, can afford to handle only high-grade logs and pay only minimum prices. On the other hand, the mill that is equipped for manufacturing a large variety of products, and has worked up a trade so that it can ship graded and partially manufactured lumber in carload lots, is able not only to use a much lower grade of logs profitably but to pay more for any given grade of logs.

Because of its misuse, the portable sawmill has a very unenviable reputation. The owner of a portable mill ordinarily has no permanent interest in the woodlands in which he has been operating. His habit has been either to buy the standing timber alone and cut it off as soon as possible, or to buy a woodland, strip it, and then dispose of the land. Under such a system there was no incentive for woodland improvement. His profit has often been a speculative one, secured because of his ability to buy timber at less than its real value, rather than as a legitimate return from manufacturing.

Used properly by a cooperative association, the portable mill may well become a beneficial instrument in the handling of a forest. The manager of the association, knowing the amount of the various kinds of lumber that he can market to advantage, may place a mill of this kind in a valley and cut only such a quantity of lumber as will be in keeping with the productive capacity of the woodlands. The next season the mill may be transported to another section, and so on for a series of years. It may then be brought back for a second cut in the first valley, when the reserved growth has had an opportunity to develop.

It must not be supposed that the advantages of such an association are wholly commercial in the narrow sense of the term. If the woodlands are made more profitable to their present owners, these owners will be encouraged to raise more and better lumber, and future woodland owners, in their turn, and the public as a whole, will benefit thereby. Nor is it the object of a cooperative association to do away with the independent millman. It has no desire to eliminate a legitimate sawmill business. In the scheme of things as outlined in this bulletin, the sawmill man has a place as a manufacturer and he may be as constructive a factor in a community as he has sometimes been destructive. But the speculative feature of the sawmill business has been injurious to the forests and baneful to the industry itself. This feature the cooperative marketing association would eliminate.

In some sections lumber may be of less importance than some of the other forest products, such as railroad ties, pulpwood, tanning-extract wood, fuelwood, fence posts, telephone and telegraph poles, piling, etc. It will often be possible for an association to serve its own members by supplying them with fence posts or building material for barns, silos, etc. In fruit-growing regions farmers are frequently charged very high prices for boxes and barrels. The machinery for making these is usually too expensive for an individual fruit grower to buy, but would be well within the reach of an association, and the making of their own containers would enable the members to pack their fruit at a reduced cost. The same principles apply to containers for butter and certain other kinds of farm produce.

ORGANIZATION OF A COOPERATIVE ASSOCIATION.

An association of woodland owners should represent a sufficient amount of timber to operate for a considerable term of years, if not indefinitely, the particular line of industry it is proposed to undertake. The amount of timber necessary would depend entirely upon the kind of industry adopted and the length of time it was intended to run. Thus, a regular sawmill industry that is to be run on a permanent basis must have a large supply of timber available, whereas a portable mill could be run for a few years on a relatively small amount. An industry that works up a finished product, such as butter tubs or shoe lasts, would require less timber than a sawmill. While it is conceivable that it might pay to organize a cooperative association to market 5,000,000 feet of lumber, the product of perhaps 1,000 acres of woodland, it is evident that an organization would mean vastly more in profit, convenience, and possibility of forestry practice to the owners of 25,000,000 feet. In any case, the capital to be invested in equipment would depend, of course, upon the amount of timber available for manufacture. The ideal arrangement would be so to operate all holdings of the association that the average annual cut would not exceed the yearly growth. Members should bind themselves to cut in accordance with forestry principles so that the productive capacity of the woodlands would be kept up.

Unlike a noncooperative stock company in which each share usually has a vote,[1] a cooperative organization is ordinarily one in which all members have equal voting power. This association would admit as members all woodland owners so situated as to be able to take advantage of the association's opportunities, whether of manufacture or shipping. No one would be allowed to buy stock in the association who was not a woodland owner. The owner of 1 share would have the same voice in the handling of the business as the owner of 10 or more shares.

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[1] Separate from Yearbook, U. S. Department of Agriculture, 1917, No. 738, Cooperative Marketing: Where? When? How?

While noncooperative stock companies distribute their profits in the form of dividends on their capital stock, cooperative organizations having capital stock limit the dividends to a fair rate of interest on the capital invested, and distribute the surplus, if there be any, on the basis of the business done by each member through the association. On this plan the man who furnished $1,000 worth of business would receive ten times as much of this surplus as the man who furnished only $100 worth of business. The association should limit the transfer of shares of stock wherever this is permissible under the law. A member would have the right to give away or retain for his own use such woodland products as he may wish, but he could not sell to any outside parties any products he has promised to the association, except such products as are not accepted by the association.

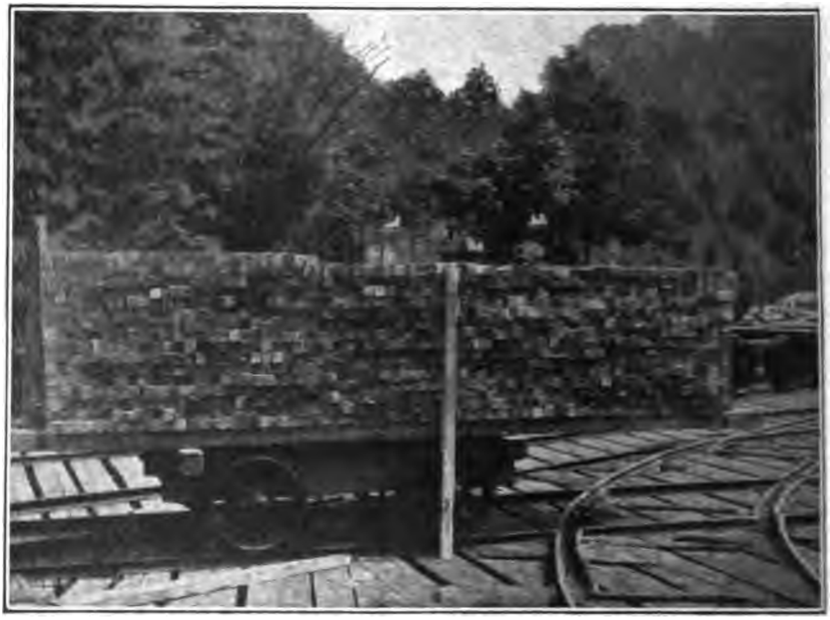

FIG. 5.—A cooperative association could advantageously manufacture the squares for turning without undertaking the turning business itself.

A manager should be employed by the board of directors and should have large powers. He should be the expert on marketing the product of the association, and should make arrangements for its manufacture, grading, shipping, etc. He should enter into contracts for the sale of the association products, subject only to the action of the board of directors and to the by-laws and rules of the association. He should give a surety bond in excess of the value of property he is likely to handle at any one time. The cost of such a bond may be paid for by the association.

FINANCING A COOPERATIVE ASSOCIATION.

The amount of capital required to finance the operations of a cooperative association will necessarily vary according to the lines of business to be pursued. If, for example, the association makes an arrangement with some local millman to saw the lumber for its members, it will not need capital for the purchase of a plant. In this case its main function will be the shipping and sale of its product after the manner of many fruit-shipping associations, which pool their fruit according to grade and variety and prorate their receipts. If, on the other hand, a sawmill, turning plant, or other wood-using industry is to be operated by the association, considerable capital will be required to purchase a plant and to operate it. In any case the salary and expenses of the manager must be met, and a competent clerical force must be maintained, as it is very important to have accurate accounts of all transactions.

It is essential that an association shall be adequately financed either by the sale of stock or through loans. After the credit of an association has been established, it is possible to secure loans from the local banks upon association notes signed by the financial officers of the association. At first it is usually necessary to borrow upon notes based on the personal credit of members.

METHOD OF ORGANIZING.

There are ample opportunities for a great number of these cooperative associations in all of the woodland sections of the eastern part of the country, where the woodlands on farms aggregated 143,391,568 acres in 1910. To be sure, greater progress in cooperative organization has already been made along agricultural lines in the Middle West, and it may be easier to start this new movement in that section. However, the opportunities for usefulness are greater in the Northeast, where there are excellent markets far removed from the virgin timber of the South and Northwest, and where a greater part of the farms is wooded than in many sections of the country.

The machinery for interesting the farmers in all advance movements is becoming centered more and more in the extension services of the various agricultural colleges. With the increased funds available under the Smith-Lever Act, it should be possible for many of the extension services to assist in the marketing of woodland products. In States having well-developed forestry departments the work can undoubtedly be conducted cooperatively by the State forestry department and the extension service. The Bureau of Markets, through its field agents, is also in a position to aid in this work.

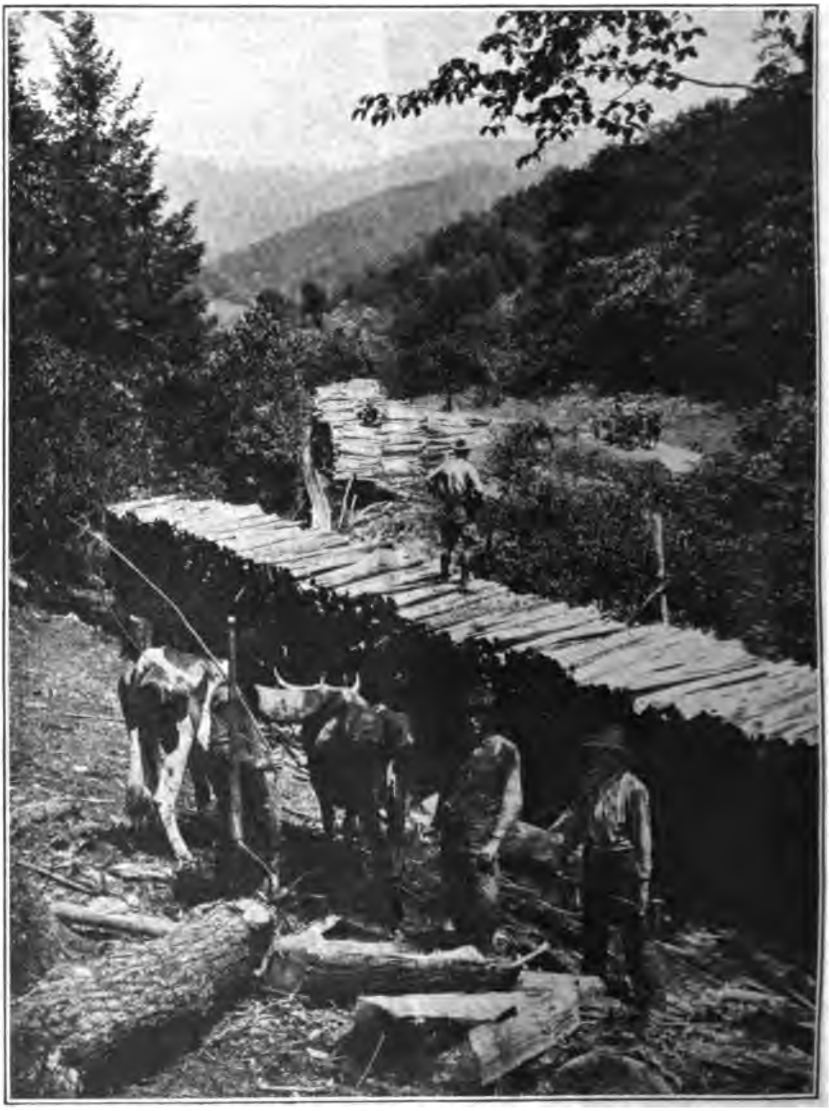

FIG. 6.—Acid wood and pulpwood corded on a flume.

Marketing specialists might be employed who not only have had experience in the marketing of lumber and other woodland products, but are good organizers and have a working knowledge of forestry.

It would be the chief duty of such a specialist, in cooperation with the county agents, to organize cooperative associations and assist them in carrying on this work. He should devote his efforts at first to two or three counties selected by the county agents as most likely to be interested in this movement. More difficult counties, where there may be even more need for such associations, should be left until later. A few successful examples of cooperative associations will constitute a most convincing argument with the woodland owners of the State.

BENEFIT TO WOODLANDS MADE POSSIBLE BY COÖPERATIVE MARKETING ASSOCIATIONS.

Through the cooperative marketing association there will be made possible practical application of much advice which woodland owners have received from foresters and from the literature published by the Department of Agriculture and the various States. The manager of the association, though not necessarily a trained forester himself, will have a working knowledge of the subject. He will be able to advise each owner as to which trees should be cut and which should be left for future growth. He will know what damage is done to trees by the more injurious insects and tree diseases, and will be able to assist the owners in a practical way in combating these forest enemies, and in helping to prevent their spread. He will thus render a great public service. When the oak in southern New England is attacked by the gipsy moth, or the chestnut of Pennsylvania by the chestnut-bark disease, or the white pine by the blister rust, the owners will be advised as to what they should do to meet these plagues. Manager and owners alike should get in touch with the State and Federal agencies having in charge the control of such pests or diseases. What and where these agencies are may be easily ascertained in every case by inquiry addressed to the State forester of any given State, or to the Secretary of Agriculture, Washington, D. C.

It will be the duty of the manager of an association whose territory is invaded by any injurious insect or disease to study the market conditions and devise ways of marketing such material that will be profitable to the owners. In some cases this will mean the introduction of special industries or machinery to work up the material. In many white pine forests which have been seriously infected by the weevil the trees are very crooked, yet the portions of the logs between the whorls of branches are of excellent quality for matches or other short material. When an association controls a sufficient amount of such material, it will be practicable to arrange for the introduction of an industry for working it up.

In many regions pine reproduces especially well under birch or other inferior trees which, in a few years, will kill out or seriously damage the pine if left to shade and rub against it. Under present conditions this birch is usually marketable for fuel alone, and for this it is only a second-rate wood. When a sufficient amount of birch is controlled by an association, it will be possible to introduce an inexpensive plant for making spool or bobbin stock, thus giving the owners a profit from the birch and a chance to free the pine and to make it much more profitable in the future.

Abandoned fields often reproduce to an exceedingly thick stand of spruce or pine, in which the trees are so closely crowded that their growth is seriously interfered with. Under the present conditions it is impracticable to thin such stands, because there is no market for the material cut. It may not always be possible even for an association to find an industry to utilize this material, but it will be easier for an association controlling a large area than for a single owner.

COOPERATIVE MARKETING AND COMMUNITY DEVELOPMENT.

Not the least valuable result to be expected from cooperative forest products associations is the establishment of permanent local industries and the attendant prosperity of the community as a whole, in sharp contrast to the exploitation of forests by temporary industries and imported labor.

This country has much to learn from such countries as France regarding the proper handling of woodlands and the development of permanent local industries. "The lumber industry in France is composed of many enterprises, stable and permanent in character, and adapted in size to utilize the material that regularly may be taken from the forests. Compared to American standards, individual sawmills and their contributing logging operations are small. The industry, however, has become an essential factor in the community. Labor is local and permanent. Many persons work in the woods and in the mills a part of the time and at other seasons on the farms and in other undertakings. Thus, in many mountain sections, the woods work is pretty largely carried on by the peasants. The trees are cut at one time of the year and brought to the roads, and later on are hauled out by the peasants when their oxen, horses, or mules are not used for farm or other work. So, also, many local people work part time in the sawmills and the concerns that make a great variety of products from the forests."[1]

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[1] Effect of the War on the Forests of France, by Col. H. S. Graves, American Forestry, December, 1918, vol. 24, No. 300.

Throughout France are local industries manufacturing a great variety of articles from wood. The manufacture of barrels and casks is of great importance in the wine-growing section. Furniture and cabinet shops are found in nearly all large towns and in many small ones. Quantities of wood are used in the manufacture of wooden shoes and wooden soles and heels. In addition to these and other industries using wood on a large scale, there are thousands of small woodenware factories and a multitude of home industries that use wood. Great quantities of toys, fans, paper knives, brushes, spoons, handles, spindles, funnels, and boxes of various kinds are turned out by the farmer-workmen all over France. Wood is obtained from the nearby forests and mills, the peasant workers having their own lathes which they use at odd times.

In the United States the tendency in the past has been too much to develop the wood-using industries as temporary affairs entirely apart from the community life. Forest resources have been exploited on such a large scale that imported labor has been required to supplement the local labor. The result is that after a few years' operations the timber resources are gone, and there is no profitable winter work for the farmers. This has been one of the important causes for the abandonment of farms and of whole communities in the less favorable agricultural regions. Certain localities in New England, Pennsylvania, and other States illustrate this regrettable condition.

It is not claimed that cooperative marketing associations alone will rectify all the mistakes of the past, but it is believed that they may be of great service in building up permanent wood-using industries near the bases of supplies, and in developing more prosperous rural communities.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

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